POWER

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Do It With Machines

JOHN H. PATTERSON, founder of the National Cash Register Company, was a strong believer in the impelling power of good mottoes.

One of these that he had painted in large letters under the eaves of one of the five-story buildings was:

A man should not be employed at a task a machine can perform.

From a humanitarian point of view, human effort and human endurance should not be taxed with tasks that can as well or better be done mechanically.

When the operation is one that a machine can do, and it has to be repeated often enough and times enough so that considerably less human labor will be spent in producing, maintaining and operating the machine than the machine will save, the mechanical operation is warranted not only from a humanitarian but from an economical point of view.

The record of human progress is full of short-sighted attempts on the part of those whose occupations would be disturbed or whose interests would be affected to prevent, sometimes even by violence, the substitution of mechanical for manual processes.

It is hard for one who sees himself being put into the discard and his knowledge of and proficiency in a certain line rendered unremunerative to see and acquiesce in the general benefit of such a change.

But to lighten the labor of the race is real progress. To make available more product with less human labor means the possibility of more of the good things of life for everybody.

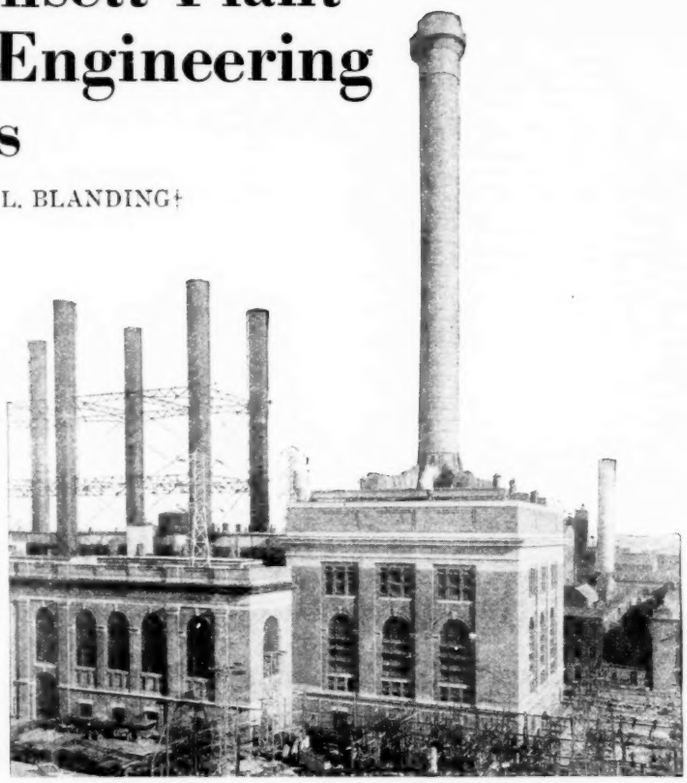
And many more people now find profitable employment in any of the trades that have been affected than when the work was done by hand.

F. R. Low

Enlarged Narragansett Plant Embodies Unusual Engineering Features

By D. H. COUCH* and ROBERT L. BLANDING†

NEW 35,000-kw. turbine in South Street Station of the Narragansett Electric Lighting Company bleeds up to 60 per cent of the throttle steam for feed heating. Steam at 375 lb. and 200 deg. superheat supplied by four 20,000-sq.ft. boilers of latest design. These burn pulverized fuel and are equipped with three different types of air preheaters. Old section of plant, running partly on stokers and partly on pulverized fuel, also equipped for oil on certain boilers. Steam tie to new section through reducing valve and desuperheater. New turbine exhausts to world's largest single-body jet condenser. Huge hot-process softener used.



The large stack marks the new boiler house

WITH the recent completion of a 35,000-kw. addition, the South Street Station of the Narragansett Electric Lighting Company in Providence, Rhode Island, is one of the most interesting of the country's large stations from the engineering point of view. It exhibits in a single structure three types of firing (pulverized fuel, stokers and oil burners), jet-condenser operation and water softening on a large scale, air preheaters of three different types, the latest equipment and furnace design for pulverized coal, a novel heat balance to meet a special condition and the tying together of two station sections operating at different steam pressures and temperatures. Growing load, rapidly changing engineering practice, local water conditions and a special fuel situation are the principal causes for the unusual layout, as will be explained.

Changes of special interest started back in 1921. In 1920 the plant generating capacity was 80,500 kw. in five units. All exhaust to jet condensers, the corrosive water of the Providence River making surface condensers impracticable.

Steam for these turbines was furnished by 24 water-tube boilers, twenty of these having 6,000 sq.ft. of heating surface each and four 4,400 sq.ft. All were fired with underfeed stokers. The steam pressure was 210 lb. and the superheat 125 deg. These boilers are numbered 1 to 24 in the accompanying plan view of the station (Fig. 1).

Because of a rapid increase in load, a second 45,000-kw. cross-compound turbine was installed in the early part of 1921. The increased steam demand was anticipated by the installation in 1921 of eight more 6,000-sq.ft. boilers (Nos. 25 to 32). These were equipped with mechanical oil burners. During the same year all the remaining boilers were changed over to oil.

This change to oil was the logical result of an unusual fuel situation. The price of coal—always high in New England—rose to a prohibitive level in 1920 because of strikes. At the same time the establishment of an oil refinery in Providence made possible a very favorable two-year contract for fuel oil. Under the existing conditions the change to oil resulted in a large net saving.

But conditions changed; oil went up and coal came down until, in 1924, a change back to coal became imperative from the point of view of economy.

This was easily accomplished in boilers Nos. 1 to 24, as the stokers had been left in place and bricked over for oil burning. The burners and brickwork were removed and the stokers restarted with little expense.

The last eight boilers (Nos. 25 to 32) having no stokers, it was decided to equip them for pulverized fuel. Experiments with pulverized fuel had been started on Nos. 22 and 24 back in 1921, using a single unit ball-type mill for the two boilers.

In putting these eight boilers onto pulverized fuel, much pioneer work was done, the horizontal Couch-type burner with short flaring flame being developed to keep down furnace volumes without undue deterioration of the refractories. These boilers have 0.36 cu.ft. of furnace volume per square foot of water heating surface and are regularly operated at from 23,000 to 27,000 B.t.u. per cu.ft. Lack of stack draft prevents going above the latter figure. Although no water or air cooling is used on the walls, these furnaces have operated with little maintenance expense.

In 1924 the increasing load resulted in plans for enlarging the station. The amount of condensing water

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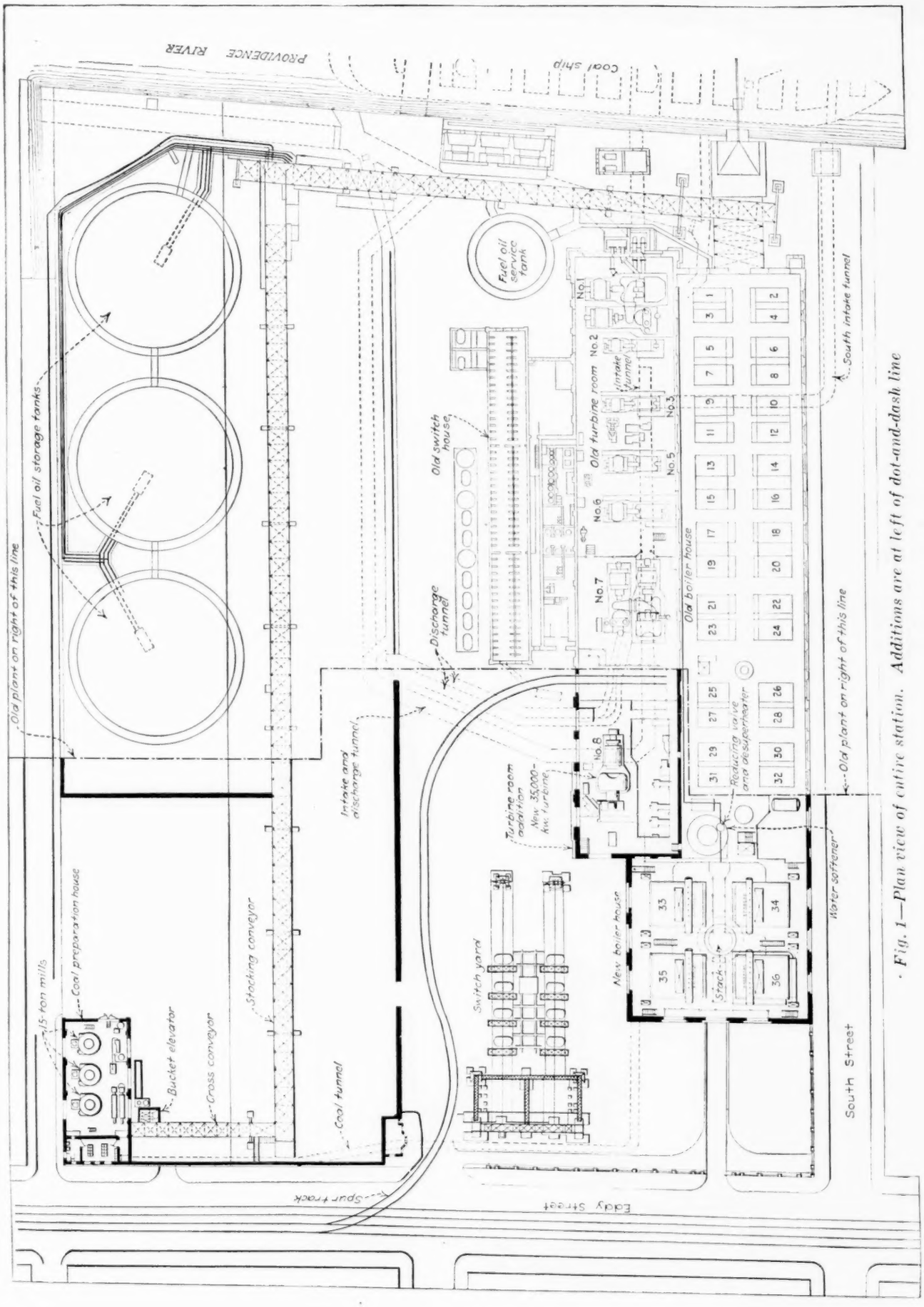


Fig. 1—Plan view of entire station. Additions are at left of dot-and-dash line

available limited the additional capacity to about 35,000 kw. It was decided to install this in a single generating unit. The boilers of the old plant, being unable to handle the full generating capacity of the old turbines without loss of efficiency due to overloading, called for the installation of boiler capacity somewhat in excess of the requirements of the new unit.

The plan selected specified four large boilers burning pulverized fuel and equipped with air preheaters. Advances in engineering practice called for a higher pressure than that used in the old plant. A pressure of 375 lb. (200 deg. superheat) at the boilers was selected and provision was made to tie in with the old mains through a reducing valve and desuperheater. The plans included a single steel stack to handle the four new boilers and a coal-preparation house of sufficient capacity to serve not only the new boilers, but the eight smaller boilers previously equipped for pulverized fuel.

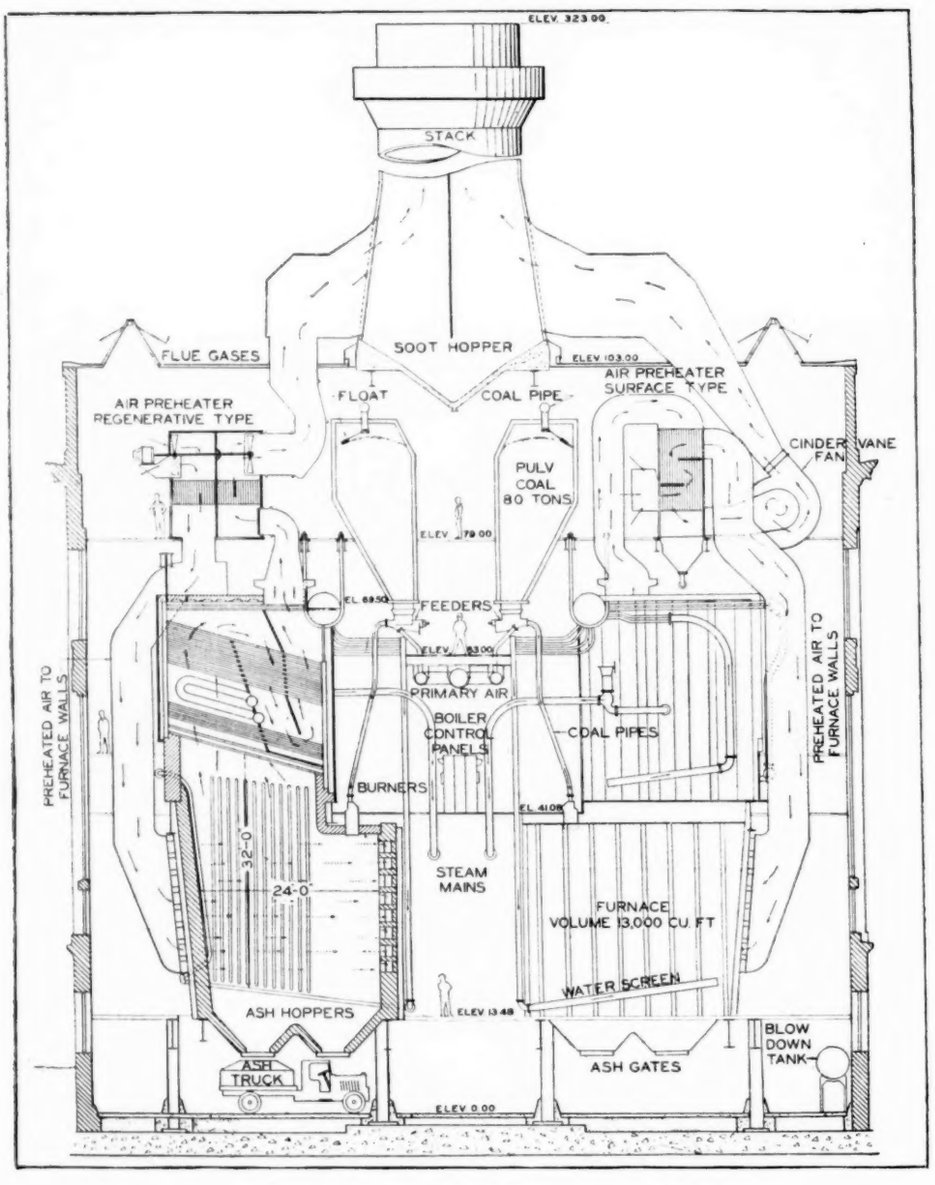


Fig. 2—Cross-section through new boiler house. There are four boilers

The whole question of condensing and makeup water was given reconsideration. Because of the corrosive nature of the river water it was decided to adhere to the use of jet condensers. The new unit was equipped with the largest single jet condenser so far constructed.

In the old plant no water treatment had been used beyond the introduction of soda in the feed-water heaters. In spite of the low amount of hardness in the city-water supply used for makeup (less than three grains total solids per gallon) the rigorous operating conditions in the new boilers—particularly in the water screens — and the fact that jet condensing necessitated about 60 to 90 per cent makeup, made a softener advisable. The single hot-process continuous softener now installed has a capacity of 700,000 lb. per hour.

Another problem arising out of recent engineering progress related to the utilization of bled steam for heating the feed for all boilers—not merely the new boilers. The old turbines not being adapted to bleeding, the new generating unit was designed for a degree of bleeding hitherto unheard of in central stations of this size. This unit is bled at three points, and, under certain conditions, discharges to the condenser only about 40 per cent of the steam supplied at the throttle.

Following this outline of general developments since 1920 and their effect upon the design of the station, a brief systematic description of the main features of the latest addition will be of interest.

The old coal-handling system, consisting of hoisting tower (on water front), and bucket, storage and reclaiming conveyors, is being remodeled, but is now in use delivering coal to a belt conveyor which carries it over a magnetic tramp-iron-separating pulley to belt conveyors above the overhead bunkers in the coal-preparation house. The present bunker capacity is about 900 tons.

Passing through driers of the Trenton Channel type (heated by boiler steam through a reducing valve), the crushed coal flows to three 15-ton roller-type mills. Their "cyclones" deliver to two screw pumps serving two 8-in. coal transport lines to the boiler house 400 ft. away.

Rising to the top of the new boiler house, the coal

pipes discharge into four 80-ton bunkers, one for each boiler. Branches run to the old boiler house to supply the eight old boilers previously mentioned.

Each boiler has eight burners passing downward through an extension arch on the second-floor level.

The boilers are of the cross-drum, horizontal, sectional, water-tube type with sinuous headers. The 4-in. tubes are 22 ft. long and are arranged in rows 36 tubes wide. Two of the boilers are 18 tubes high with 17,084 sq.ft. of water-heating surface each (not including wall or bottom screens), and two are 20 tubes high, having 18,755 sq.ft. of water-heating surface. Of the 1,650 sq.ft. of screen surface in each boiler, 670 sq.ft. is set flush in the side walls, while 980 sq.ft. is across the bottom of the furnace and in front of the rear wall.

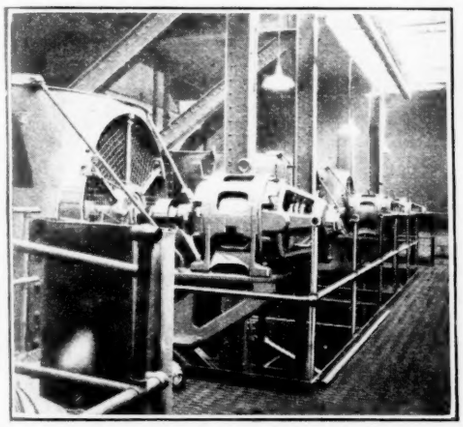
As already mentioned, the steam pressure is 375 lb. at the boilers. To insure 200 deg. superheat, in spite of the expected cooling action of the water screens, an unusually large interdeck superheater (4,316 sq.ft.) was

counts for the use of 18-high boilers with these instead of the 20-high boilers used with the plate-type and tubular preheaters.

With the rotating preheaters the forced and induced-draft fans are integral with the preheaters, while individual forced and induced-draft fans are used on the other two boilers. All fans are driven by 2,300-volt slip-ring motors with push-button control. Two motors, one small and one large, are used on each individual induced-draft fan. When the speed rises to 290 r.p.m., the load automatically shifts from the small to the large motor, the latter carrying it on up to 440 r.p.m.

Two ducts carry preheated air down along the back of each furnace. Entering the various belts of the double wall, it passes around the furnace and then into the combustion space through openings in the front wall. Primary air for the burners is drawn off by motor-driven fans from the preheated-air ducts.

A single steel stack of 19 ft. internal diameter and



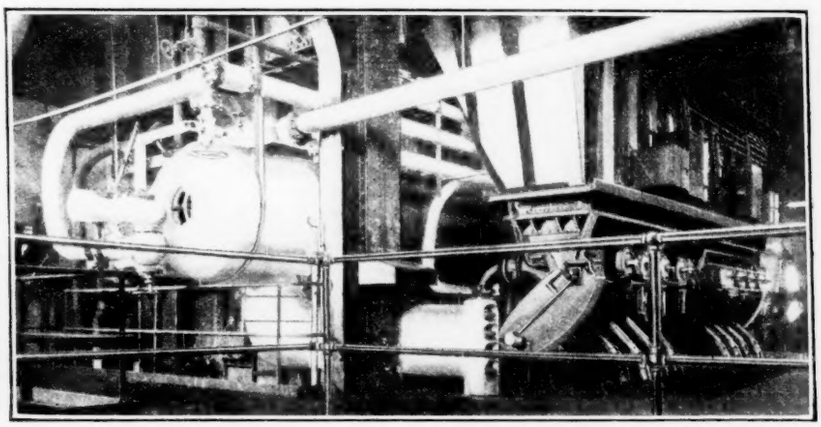


Fig. 3—Regenerative air heaters. Fig. 4—Drum and pulverized-coal feeders on one of four new boilers

installed above the sixth row of tubes. Superheats actually obtained run around 225 deg. at 200 per cent of rating.

The boilers are of impressive size, the center of the drums being about 70 ft. above the ashroom floor. The furnace volume under the 18-high boilers is 13,000 cu.ft. For the 20-high boilers it is 12,680 cu.ft.

To permit testing the evaporative capacity of the screens, one boiler is equipped with an auxiliary drum divided by a cross partition at the center. One end of this drum supplies water to and receives steam from the side-wall screens. The other end serves the rear wall and bottom screens. Provision is made for separate metering of the steam from each end of the auxiliary drum.

The new boiler house will serve as a proving ground for air preheaters. Three types, regenerative, tubular and plate, have been installed. Each of the 18-high boilers is equipped with two air heaters of the rotating regenerative type. These have 40,000 sq.ft. of regenerative heating surface each, a total of 80,000 sq.ft. per boiler. Of the remaining two boilers one has a 14,961-sq.ft. tubular air heater with air flowing up around the tubes, and the gases passing down through them. The other 20-high boiler has a counterflow plate-type preheater with 14,100 sq.ft. of heating surface.

Preheaters are used instead of economizers to take full advantage of the bleeding cycle. The greater heat-recovering capacity of the regenerative air heaters ac-

rising 317 ft. above the street level, serves the four boilers. It is supported on the boiler-room steelwork

Fig. 5 shows the heat-balance system employed. Its outstanding feature, as already noted, is the use of bled steam from the new turbine to heat feed water for the entire plant.

The use of jet condensers makes primary heaters essential for economy. The water is heated successively by the turbine-oil cooler, generator, air cooler, primary heater, air-pump inter-condenser, fourteenth-stage heater, air pump and gland steam after-condenser, twelfth-stage deaerating open heater (on softener) and eighth-stage heater. The final feed temperature is around 325 deg. F.

A special connection permits supplying steam to the open heater from the eighth stage when low load forces the twelfth-stage pressure below atmospheric.

Heat recovered ahead of the primary heater has no particular value, since unlimited amounts of "free" exhaust steam are available for the primary heater. Provision is made to cut the generator-air-cooler water out of the feed circuit and continually recirculate it through the secondary cooler which is supplied with salt water.

Primary heaters are also installed on the exhausts of the two 45,000-kw. cross-compound units. Inter-cylinder bleeder connections will be provided for emergency use.

At present most of the feed-water heat for the old

plant comes from steam-driven auxiliaries, but this will be cut down as these auxiliaries are motorized.

Mention has been made of the softener. This is designed to handle 700,000 lb. per hour. It has the usual chemical proportioner, chemical tank and an open deaerating heater. The sedimentation tank is 35 ft. high (including conical bottom) and 25 ft. in diameter. Space is provided for the installation of a duplicate softener to supply the old boilers.

Provisions for testing include a double-tank water-measuring system designed to handle 550,000 lb. per hour. This takes feed water from the softener, as no condensate is available with the jet condensers.

For the new boiler plant a pulverized-coal weighing system with two ten-ton tanks is being installed. Coal will be weighed before being delivered to the individual boiler bunkers. Four sounding floats in each bunker permit corrections for differences in level when starting and stopping tests. The entire pulverized-coal handling control is centralized on one board in the boiler room.

Piping for the main steam and feed-water lines is in accordance with the A.S.M.E. 400-lb. standard. VanStone joints are used with spiral "phonograph" finish and gaskets. The valves, wherever possible, are faced "large female." Some VanStone joints have been welded, but only on the main steam lines. Seamless piping is used for all small high-pressure piping.

The new plant is well-equipped with instruments, mostly of the recording type. A venturi-tube meter on each boiler measures the feed, the combined blow-down being measured by a V-notch meter. Each boiler is provided with a gage board carrying instruments giving steam flow and all important pressures and temperatures of gas, air and steam, fan speeds, fuel-feeder speeds, etc.

The turbine gage board is especially interesting, as on this are mounted instruments for completely recording all functions of the heat-balance system, both temperatures of steam and water pressure being indicated and recorded.

Recording instruments, centralized on one board, give temperatures and pressures for all important points in the heat balance system. Pressure and flow are recorded for the turbine throttle and all bleed points.

All new auxiliaries are electrically driven, except the stand-by feed pumps, which have turbine drives. The drives are alternating-current motors—550 volts for small motors and 2,300 volts for motors of 50 hp. or more. Direct-current motors are used on the coal feeders.

Power for station auxiliaries is supplied jointly by step-down transformers and house generators. Two 4,000-kw. turbo-generators were already installed in the station and are being used as house generators. These serve the essential auxiliaries only.

Push-button control is used on many of the auxiliaries. Motor-operated valves are extensively used.

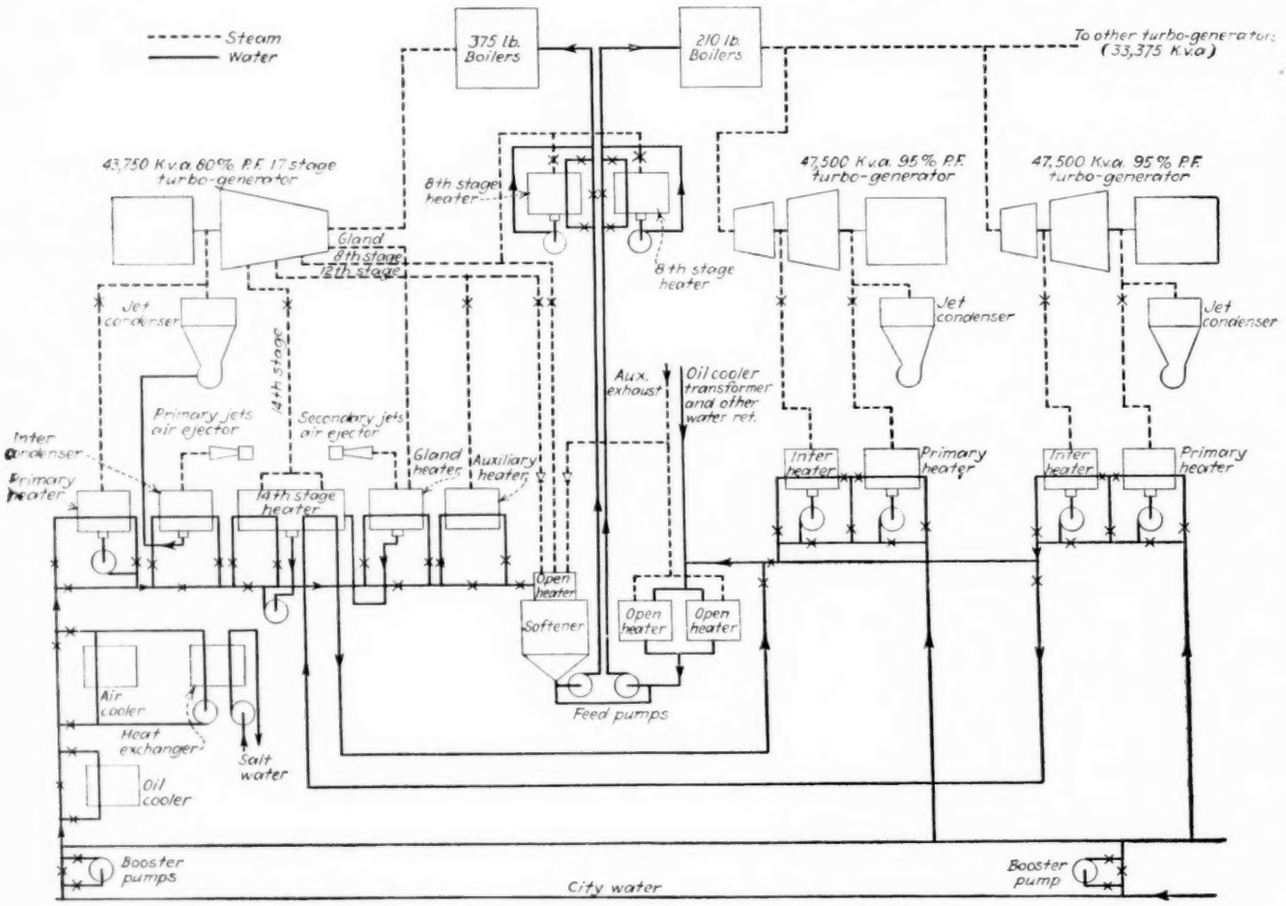


Fig. 5—Heat-recovery diagram, showing how excess steam bled from new turbine helps heat feed water for old plant

The new equipment has not been in operation long enough for reliable test data to be available. When such information is obtained, it will be of great interest to designers. The layout should make possible a fairly complete analysis of heat absorption in boilers by side-wall screens, rear and bottom screens and regular water-heating surface. The same applies to heat transfer in air preheaters of the plate, tubular and regenerative types. Another matter of great interest will be the detailed working out of the novel heat-balance system with its heavy bleeding of the new unit, etc.

The recent additions were by Jenks & Ballou, Engineers, Providence, co-ordinating with the operating staff of the Narragansett Electric Lighting Company.

PRINCIPAL EQUIPMENT OF 1925-26 ADDITION TO SOUTH STREET GENERATING STATION OF NARRAGANSETT ELECTRIC LGHTING COMPANY

GENERAL

Installed capacity, kw.: Old plant	125,000
Additions	35,000
Total	160,000

COAL HANDLING AND PREPARING EQUIPMENT (Including burners)

Two bucket elevators, 100 tons per hour each	Link-Belt Co.
Four belt conveyors, 200 tons per hour each	Link-Belt Co.
Three duplex driers, Trenton Channel type	Combustion Eng. Corp.
Three 15-ton Raymond roller-type pulverizing mills	Combustion Eng. Corp.
Two DHC 10-in. screw-type coal pumps	Fuller-Lehigh Co.
Thirty-two burners (8 per boiler)	Combustion Eng. Corp.
Four Duplex feeders on one boiler	Bailey Meter Co.
Twenty-four feeders (8 per boiler)	Combustion Eng. Corp.

BOILERS, SUPERHEATERS AND FURNACES

Four cross-drum, horizontal, sectional, water-tube boilers	Babcock & Wilcox Company
Tubes	4-in. x 22-ft., 36 tubes wide, 18 high in two boilers, 20 high in other two.

	18-high Boilers	20-high Boilers
Heating surface, regular sq.ft.	17,084	18,755
Screens sq.ft.	1,650	1,650
Total sq.ft.	18,734	20,405
Furnace volume, cu.ft.	13,000	12,680

Four interdeck superheaters, 4,326 sq.ft. each	Babcock & Wilcox Co.
Four boiler control panels	Bailey Meter Co.

AIR PREHEATERS AND FANS

Four rotary regenerative air heaters (two on each 18-high boiler)	Air Preheater Corp.
Size and drive	40,000 sq.ft. regenerative surface (each). Heater and self contained fans driven by 100-hp. slip-ring motor.
One, 14,100-sq.ft. plate-type air heater	Combustion Engineering Corp.
One, 14,961-sq.ft. tubular air heater	Babcock & Wilcox Co.
Two forced-draft fans (40-hp. motors)	B. F. Sturtevant Co.
Two Cindervane induced-draft fans (each with one 50-hp. and one 200-hp. motor)	B. F. Sturtevant Co.
Four primary air fans (50-hp. motors)	B. F. Sturtevant Co.

CHIMNEY, AIR DUCTS AND BREECHING

One stack	Chicago Bridge & Iron Works
Description	Full-lined steel, supported on building steelwork, 19 ft. inside diameter, height above street floor, 317 ft.
Accordion-type air ducts and breeching	Connery & Co., Philadelphia, Pa.

TURBO GENERATOR

Made by	General Electric Company
Operates at	1,800 r.p.m., 11,000 volts, 3-phase, 60-cycle.
Output at 80 per cent P.F., kw.	35,000
Output at 90 per cent P.F., kw.	43,750
Type of turbine	Reaction Curtis, 17-stage, bleeding at 8th, 12th, and 14th stages, designed to bleed up to 60 per cent of throttle steam.
Steam conditions at throttle	350 lb. gage, and 635 deg. F.

Guaranteed Steam rate without bleeding, at 29 in. Vacuum.

Load, Kw.	Lb. per Kw.-Hr.
43,750	10.50
35,000	10.20
31,000	9.85
25,000	10.05
15,000	10.70

Ventilating air, cu.ft. per min.	100,000
Supplied by	4 external fans (75-hp. motors)
Exciter	Direct connected

CONDENSER AND AUXILIARIES

Made by	Elhott Co.
One single-jet condenser, lb. steam per hr.	350,000
Two removal pumps (250-hp. motors), gal. per min., each	18,000
One steam-jet air pump with inter-condenser, cu.ft. free air per min.	223

CENTRIFUGAL BOILER-FEED PUMPS

One 5-stage, 1,000-gal. per min. (400-hp. motor)	Ingersoll-Rand Co.
One 6-stage, 1,000-gal. per min. (400-hp. motor)	DeLaval Steam Turbine Co.
Two single-stage, 1,000-gal. per min., Bethlehem-Weir, steam driven	Bethlehem Shipbuilding Corp.

OTHER CENTRIFUGAL PUMPS

Three 100-gal. per min. motor-driven, condensate pumps	Elhott Co.
Two 1,000-gal. per min., motor-driven booster pumps	DeLaval Steam Turbine Co.

COOLERS, HEATERS, WATER SOFTENER, ETC.

Two 798-sq.ft. (each) oil coolers	Andale Engineering Co.
One condenser-type 4,000-sq.ft. primary heater	Elliott Co.
One two-compartment 6,000-sq.ft., condenser-type 14th-stage heater	Elliott Co.
One 12th-stage open heater, with 700,000 lb. per hr. hot-process softener, with pressure-type filters, etc.	Cochrane Corp.
Two 2,000-sq.ft., spiral-tube 8th-stage heaters	Elliott Co.
One 2,000-sq.ft., floating-head 8th-stage heater	Griscom-Russell Co.
One 2,000-sq.ft. condenser for gland and jet steam	Elliott Co.
One 1,150-sq.ft. heat exchanger (used with generator air cooler)	Croll Reynolds Co.

INSTRUMENTS (OTHER THAN SWITCHBOARD)

Type	Maker
Water-pressure recorder	The Foxboro Co., Inc.
Steam-pressure recorder	The Foxboro Co., Inc.
Stage-steam-pressure recorder	The Foxboro Co., Inc.
Indicating wattmeter	General Electric Co.
Totalizing wattmeter	Westinghouse Elec. & Mfg. Co.
Speed indicator	General Electric Co.
Pressure gages	General Electric Co.
Flow meters, bled steam	Republic Flow Meters Co.
Flow meters, main steam	Bailey Meter Co.
Temp. alarm, turbine oil supply	The Foxboro Co., Inc.
Temp. recorders	Brown Instrument Co.
Venturi meters	Builders Iron Foundry; Simplex Valve & Meter Co.
Thermometers	C. J. Taghabue Mfg. Co.

VALVES

Motor operated	Schutte & Koerting Co.; Chapman Valve Mfg. Co.; The Lunkenheimer Co.
Atmospheric relief	Atwood & Morrill Co.
Boiler safety valves ("Consolidated")	Manning, Maxwell & Moore
Throttle trip valve	Schutte-Koerting Co.
Main stop valve	Schutte-Koerting Co.
Valves (superheated steam)	Schutte-Koerting Co.
Valves feed water, forged steel	Henry Vogt Machine Co.
Small forged-steel globe valves	Edward Valve & Mfg. Co.

PRINCIPAL DATA ON ELECTRICAL EQUIPMENT, ETC.

Motors, switchboard and automatic-control panels	General Electric Co.
Motors and switching equipment	Westinghouse Elec. & Mfg. Co.
D.C. fuel-feeder motors	Electro-Dynamic Co.
Electrical construction and enclosed 2,300-volt motor-control switchboards	Carleton-Mace Engr. Corp.
11/66 K.V. outdoor sub-station	Power Construction Co.

MISCELLANEOUS EQUIPMENT

Push-button control on motors	General Electric Co.; Westinghouse Elec. & Mfg. Co.
One desuperheater	Lumsden & Van Stone Co.
Feed-water regulators	Stets Co.
Soot blowers	Diamond Power Specialty Corp.
High-pressure steel piping	Lumsden & Van Stone Co.
Forged-steel steam header	M.W. Kellogg Co.
Atmospheric relief piping (cast iron)	Lumsden & Van Stone Co.
Spiral-riv. steel pipe	American Spiral Pipe Works
Circulating-water piping	Lumsden & Van Stone; Grinnell Co.
85 per cent-magnesia heat insulation	Johns-Manville Co.; Keasbey & Mattison Co.
85 per cent-magnesia heat insulation	R. I. Covering Co.
Foundation, screen well and tunnel work	Jarrett-Chambers Co.
Steelwork	D. E. McIntire Co.; N. E. Structual Co.
Piping erected	R. H. Baker Co.
Boiler brickwork	McAleenan Corporation
Weightometers	Merrick Scale Co.
Revolving screens	Link-Belt Co.
Air-cooled furnace bottoms, with hydraulic ash gates	Allen-Sherman-Hoff Co.
High-temperature insulation	Johns-Manville Co.
Insulating brick	Celite Products Co.

Care of Commutators and Brushes

By Clair L. Keene*

COMMUTATION is of paramount importance to the satisfactory operation of a machine. It is a difficult and extensive subject both in theory and in practice. In the case of direct-current machines, it forms a reasonably fair index to the insurance engineer as to the care the machine receives. Brush and commutator troubles present the greatest sources of poor commutation, although incorrect design of the machine itself frequently results in difficulties.

Successful commutation depends to a large extent upon the selection of the brush to suit the demands of the service. Operating and insurance engineers should recognize that the time and thought spent on the selection of the most suitable brush for any given conditions is amply justified by the results obtained. Graphite-carbon brushes are accorded almost universal use for the usual commercial applications under normal conditions. These brushes are usualy artificially lubricated and contain practically no abrasive material, thus reducing wear and friction. They have fairly high carrying capacities and sufficient resistance to be used with commutating pole machines that have inherently high voltage induced in the armature coils undergoing commutation. Pure graphite brushes are soft and have a low resistance drop and should never be used where the mica of the commutator is flush with the surface or on a commutating-pole machine.

Carbon brushes are employed where special conditions are to be met. As this type of brush has a relatively large amount of abrasiveness, the commutator need not be slotted when it is used. Graphite-carbon brushes can be used on commutators flush or undercut, depending upon the amount of carbon and abrasive material in them. Metal-graphite brushes have a low transverse resistance as compared with carbon and graphite-carbon brushes and are suitable for collector-ring service and electrolytic machines where the voltage between the commutator bars is relatively low. These brushes have a relatively high carrying capacity. Experience is the best criterion in the selection of a brush, and the brush manufacturing companies can render valuable assistance in choosing the proper brush.

Position and Tension Important

Considerable attention should be given to brush position and tension. If the brush holders are not parallel to the commutator bars, glowing of the brushes and sparking at one or more studs are apt to result. Brush rigging should be strong and tight, as vibration may cause sparking at all loads. The relative spacing of the brushes around the commutator should be uniform. Unequal spacing may cause sparking at the brushes, due to their not being at the neutral points. In the commutating-pole type machines, for best results the brushes should be set on a line midway under the commutating poles. In this position the commutating poles will have no effect on the characteristics of the machine. Brush-holders should have a clearance of ⅛ in. between the surface of the commutator and the holders.

Incorrect brush angle may cause binding or chatter of the brushes, breaking of the brush tips or general sparking. The proper angle is dependent upon the speed of the commutator, the direction of rotation, the requirements of the service and the type of brush. For the usual medium-speed machines under normal operating conditions and with rotation against the sharp edge of the brush, experienced results show 37½ deg. to be the best angle to use. For rotation against the dull edge 15 to 20 deg. generally gives the best results. Brush springs should be adjusted to a uniform tension. For carbon and graphite brushes on commutators, the brush pressure should be from 1 to 2 lb. per square inch of contact surface. Collector-ring service requires from 4 to 5 lb. per square inch. Too much tension causes sparking, brush wear, excessive commutator wear, grooving, friction and the crumbling of the brushes. Insufficient brush pressure results in unbalanced circuits, poor voltage regulation and sparking. Brushes should move freely in the holders. If the brush binds, sparking and glowing will result. If the brush has too much clearance in the brush holder, it will often cause chattering.

When the Commutator Needs Attention

If the commutator needs attention, it will usually be indicated by high or low bars, high mica, eccentricity or general unevenness. High or low bars cause breaking off of the brushes and sparking. Special care should be taken to prevent the mica from becoming oil soaked. Sources of this danger are common and should be guarded against very carefully. When mica becomes oil soaked, arcing between the commutator bars is apt to ensue and may ultimately result in the commutator becoming grounded. If the commutator is appreciably rough or eccentric, it should be turned down. To prevent grooving of the commutator, the brushes should be properly staggered.

Many other causes, such as open-circuits in the armature, weak fields, grounds, variable or overloads, poorly balanced armature and faulty design affect commutation. If poor commutation in a machine is not due to strictly brush or commutator troubles, it is probably due to some of these causes.

In an Ordinary Boiler Furnace about half of the heat developed by combustion is transmitted by radiation. If it is intercepted by brickwork, this becomes extremely hot and heat is transmitted from it to the flue gas by conduction and convection. If, on the other hand, water-heating or steam-making surface is exposed so that it "sees the fire," this heat is immediately applied by radiation, and excessive furnace temperatures are avoided. Advances in the art of combustion are traceable to a growing appreciation of the place of radiation in boiler furnace heat transmission and to an increasingly clear understanding of the factors governing this process.

If Oil Is Subjected to Air While Hot, oxidation is greatly augmented. Avoid exposing to the air large areas per unit of volume of the oil, whether the latter is hot or cool, as then conditions are ideal for promoting oxidation. Turbine builders are now designing or have designed bearings and circulating systems that minimize the area per unit of volume of oil exposed to the air at these locations. The acidity of vapors arising from oil running into a turbine bearing in operation has been shown to be ten times as high as the acidity of the main body of the oil.

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Application of Surface Air Coolers to Direct-Current Machines

Outlines Some of the Problems Involved in Applying Closed Systems of Ventilation to Direct-Current Machines and Compares the Costs of Various Ways of Making the Installations

By F. S. BENNETT
Construction Engineering Department, General Electric Co.

CONVERTERS are installed sometimes in locations where a surface type air cooler would be desirable. Such locations are those requiring the elimination of noise and those where it is difficult to get the air supply in and out of the building. Synchronous converters, direct-current generators and motors present several problems requiring consideration when using continuously recirculated air. These are elimination of carbon and metallic dust from the brushes, provision of a reliable water supply and proper arrangement of the air ducts and fans.

The carbon dust from the direct-current brushes and the metallic dust from the alternating-current brushes is estimated to amount, on the average, to 450 lb. per

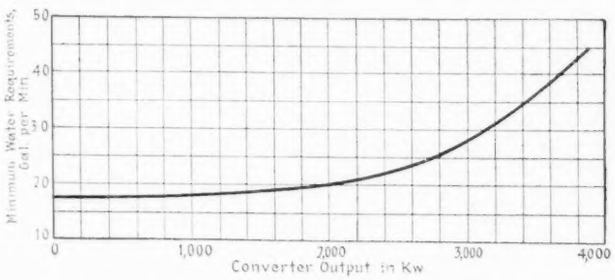


Fig 1—Water requirements for closed ventilation of rotary converters, with a 60-deg. F. water temperature

year for a 4,000-kw. synchronous converter. The deposit of this dust on the machine insulation or coolers for any length of time would be very detrimental to the machine. The deposit on the insulation could probably be removed by blowing with compressed air, but it is quite likely that the cooler tubes would become moist from condensation, and the dust deposited on them would adhere tightly. If no moisture is present on the coolers, it would still be difficult adequately to clean the interior of the tube nest with compressed air, due to the staggered construction of the tube nest. Periodic cleaning with compressed air, therefore, is rather doubtful as a means of eliminating this trouble. Experience would be the only means for obtaining a satisfactory answer.

As one alternative to periodic cleaning, a static type of filter could be placed in the air circuit. This should be of the general type of construction, using a core filled with small metal pieces covered with a viscous fluid. These filters, of course, would require cleaning, but only at relatively long intervals. Another alternative would be to draw off a definite part of the air circulated and replace it with clean air. This method presents some physical difficulties in getting rid of the dirty air and obtaining the fresh air without destroying the advantages of the closed system. The general conclusion can therefore be drawn that, having no experience, the static filter offers the most dependable means of collecting the dust.

Circulation Water Supply

The water supply for circulation through the cooler must be reliable and of the proper temperature, or the services of the machine may be lost. The water supply could be of three general sources—an independent course such as a well or stream, a city water main or a recooled system using a cooling tower either of the forced or the natural draft type.

The water supply from a well depends upon location and requires a pumping plant. The well supply is usually of limited volume but of low temperature. Fig. 1 shows the minimum volume requirements for water, based on 60 deg. F. maximum water temperature. This indicates a water capacity requirement of about 0.0113 gal. per minute per kilowatt of machine rating. This figure would be increased to 0.02 gal. for machines rated at 500 kw. or less, due to mechanical considerations in the construction of the cooling equipment.

A water supply from a stream is usually ample but of higher temperature than a well. If 85 deg. F. is fixed as a maximum temperature, a maximum of 0.063 gal. per kilowatt of rating is required. This volume will be ample for all sizes of machines for maximum capacity requirement. Recooling of the water by a cooling tower, either forced-air circulation or natural draft, is considered as a possible means of obtaining a reliable water supply.

Cooling Towers

Natural-draft type cooling towers will cost the least but take up the most space. As usually constructed, they will give rather an unsightly appearance to a station located in a residential district. This defect can be overcome by a special design to harmonize with the building and surroundings, but the cost may be increased considerably for this special treatment. The usual design requires about 0.0725 sq.ft. of space per kilowatt of machine rating and a height of approximately 18 ft. This type of tower will provide a supply of water that will always be below the temperature of the outside air. In general, the water temperature will never go above 85 deg. F. for the air temperatures and humidity encountered in the United States, except for the extreme southern part. The cost of this type of

tower, including pumping equipment, is about $0.95 per kilowatt of machine rating for capacities of not less than 2,000 kw. This rises to about $1.15 for converters of 500-kw. rating. The additional cost of ducts, cooler, fans and filter will be about $1.65 per kilowatt for the larger sizes and $1.90 for the smaller sizes. These give a minimum cost of $2.60 per kilowatt and a maximum of $3.05 per kilowatt.

Forced-air type cooling towers can be made somewhat smaller than the natural draft type. They require about 0.055 sq.ft. of space per kilowatt. They cost less than natural draft, about $0.68 per kilowatt of converter rating for the larger sizes. This type, however, has the disadvantage of using a fan that requires power and introduces the possibility of noise from the fan. The cooler and other apparatus cost approximately the same as for the natural draft tower.

Cooling the water supply by a second set of surface-type coolers has been considered. This system is not practical, since the water could never be cooled to the temperature of the air. A terminal difference of 10 deg. F. is practical. This would require that the air temperature used for cooling the water supply never go above 84 deg. to maintain a temperature of cooling air to the machine of 104 deg. The 10-deg. terminal difference requires cooling surface for absorbing and dissipating the heat that would cost $2.50 per kilowatt of converter rating. The water pump, fans, filters, piping and ducts would add about $1.25 per kilowatt, making a total cost of $3.75 per kilowatt. These costs indicate that even if the air could be obtained at sufficiently low temperature, the system would compare unfavorably with others previously outlined.

The next problem is the housing and ducts necessary. Machines have been designed with housings for supplementing the natural ventilation of the rotor with separately driven external fans. This design has been built but has not been in service for any length of time. There are some air distribution problems to be solved when adding an inclosing structure and forced ventilation to a converter. These should be the subject of special study by the designer of the machine. The ducts for a completely closed system are shown in Fig. 2. This particular design includes the ventilation of an air-blast transformer and requires a basement. The standard air-blast transformer requires a higher static air pressure for the circulation of the air than does the converter. This has been cared for by having a separate blower to boost the air pressure for the transformer ventilation.

The essential features of a design for the inclosing ducts external to those directing the air through the machine itself should be ample area of air passages, provision for draining any leakage or condensation away without entering the machine, shaping of ducts so as to give minimum static head loss, few and well-made joints, and entrance openings for inspection.

The size of the air passages directly affect the amount of power required to circulate the ventilating air. The size and shape also affect the performance of the coolers and machine by equal or unequal distribution over the radiating surfaces. It is advisable to have the coolers themselves discharge into a plenum chamber which can act as a separation chamber for any leakage or condensation. Considerable power saving can be effected by shaping the duct to prevent abrupt changes in the air velocity. The duct joints should be as few as possible and be made up with gaskets and angles of substantial section. Poorly made joints are the source of two difficulties—moisture condensation and dirt from air infiltration.

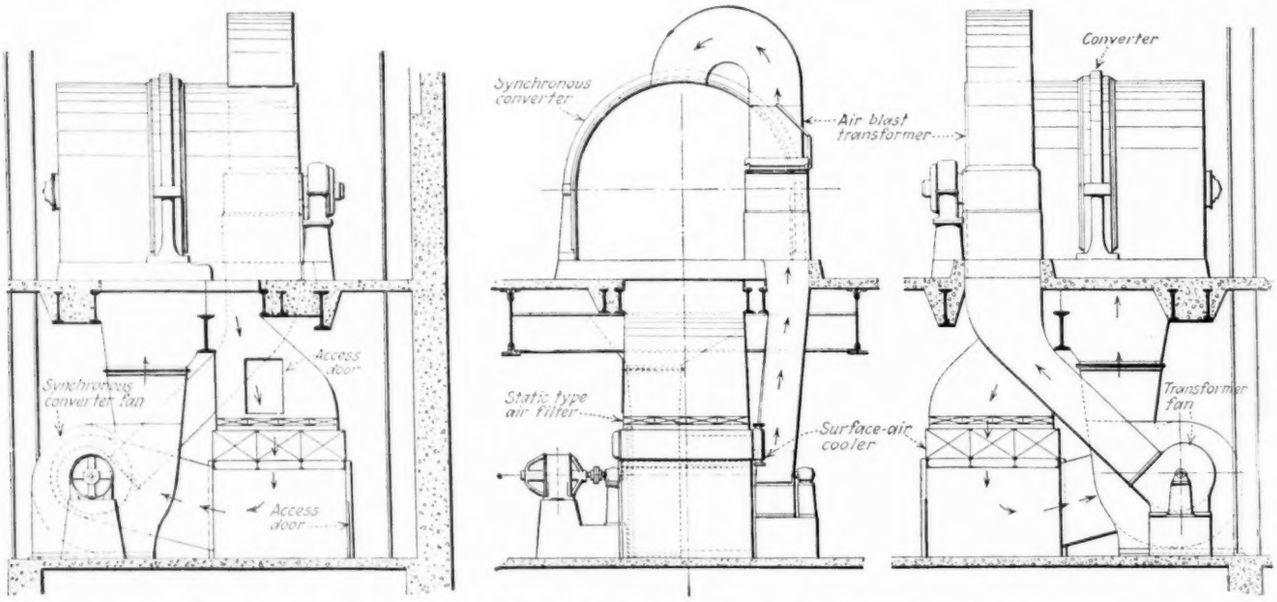


Fig. 2—Typical arrangement of closed ventilation system with surface coolers for rotary converters

The cost of surface-type coolers is not justified on converters and direct-current machines except for special conditions and locations. No installations have been tried, although studies have been made.

The general information regarding rotary converters applies to direct-current generators and motors. This application has been studied and no difficulty is expected, although in general the cost is not justified except for special locations.

How Any Fuel-Burning Equipment Is Functioning can be judged by an analysis of the flue gases, as this will show if more air is being supplied than is necessary for the combustion process and whether combustible gases are escaping unburned to the stack.

Using the Torch in the Power Plant—II*

The Use of Flux in Welding Different Kinds of Metal—Guarding Against Expansion and Contraction Strains—Cutting with the Torch

By L. A. COWLES†

BEFORE discussing the topics outlined, attention is called to Fig. 1, showing how the casting supporting a turbine governor arm was repaired by welding. The saving in this case was $12 and the elimination of a two weeks' wait for a new casting, in addition to the risk of a shutdown if anything should have gone wrong with the other unit. This illustrates the contention that the welding torch as a part of the power-

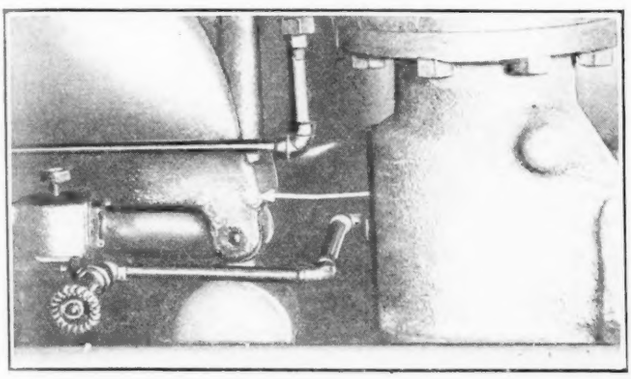


Fig. 1—A casting supporting the turbine governor arm was accidentally broken and was welded. The saving was $12 and the two weeks the unit would have been out of service

plant tool equipment not only is a good investment from a dollar saving standpoint but is, to a great extent, insurance against a shutdown.

As flux does not clean the metal, care should be used in cleaning the surfaces of any piece to be welded. Oil and dirt do not help in welding any more than they do in soldering. The use of flux is necessary in the welding of cast iron, the brazing of the various alloys of brass and copper and the welding of cast steel and aluminum. A small amount is of benefit in welding steel, and particularly is this true with a high-carbon steel. Cast-iron flux is used for steel as well as in the welding of wrought iron. The burning of the weld, indicated by an excessive discharge of sparks, must be carefully guarded against. The use of flux will not prevent it.

In welding cast iron, add the flux by dipping the filler rod into it and use no more than is needed to keep the molten metal in a mirrorlike condition. A good flux can be made from equal parts of carbonate and bicarbonate of soda thoroughly mixed. The action of the flux is to break up the oxide formed, releasing the iron in the slag and causing the oxygen to pass off as a product of combustion.

When welding steel, the oxide does not float to the surface as in cast iron, for the melting point of the steel is higher than that of the oxide, so there is a tendency for it to mix. The use of a little cast-iron flux will help in preventing this. In copper welding the flux is incorporated in the filler rod. For brazing and the welding of copper alloys, a flux must be used. Borax is good.

As a rule, flux is not used for aluminum, the oxide being worked out with a puddle rod, although in welding sheet aluminum many welders use flux. If the piece is cleaned carefully with hydrochloric acid, followed by a wash in caustic soda and a water bath, the use of flux is not necessary. The welding of aluminum is difficult, but fortunately is not often required in the plant.

In the case of malleable iron, the most satisfactory repair is made with manganese bronze or tobin bronze.

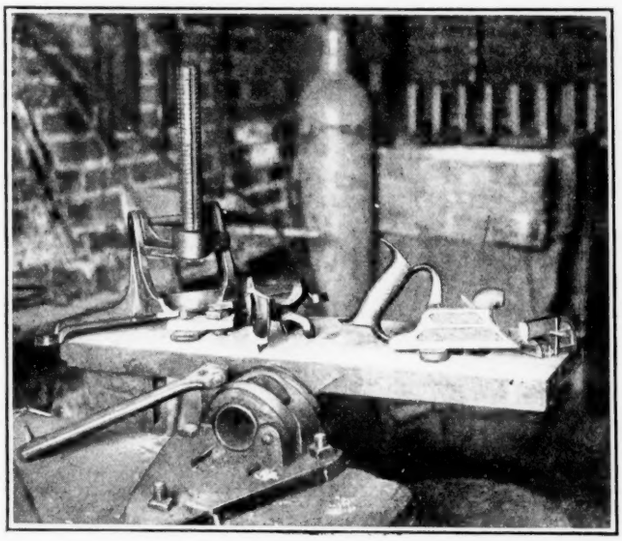


Fig. 2—The boss leaned back and broke a chair casting. Does the fact that it can be repaired at his power plant only 400 ft. away make a hit with him? Is the carpenter glad to do work for us? Surely! Why not? Look at the plane he wants fixed

Here brazing flux or borax is used. The use of the manufactured fluxes and welding rods, instead of the home-grown variety, is recommended. Manufacturers of these products will give detailed information as to their application.

For the welding together of dissimilar metals, use a filler rod as nearly as possible like the metal that melts at the lowest temperature. This can be determined by applying the flame to the two metals equally and noticing the first to melt.

*The first article, which appeared in last week's issue, outlined the equipment necessary for the average plant and gave instructions for making a weld and testing for leaks.

†Chief Engineer, University of South Dakota, Vermillion, S. D.

There will be no occasion to do much more than call attention to the fact that allowance must be made for expansion and contraction strains, due to the heating and cooling of the metal in welding. Cast iron and aluminum probably cause the most trouble from this source, although in the welding of sheet steel and steel castings this factor must be considered. As a rule, small castings do not require previous heating, although it is good practice, after completing the weld, to cover them with asbestos, so that they will cool slowly. Asbestos cement is fine for this purpose and if there is much pipe covering to do, a supply of this material will be on hand.

When welding a long break in cast iron, it is a good plan to heat along the line of the weld and any parts that will be subject to strain, occasionally playing the

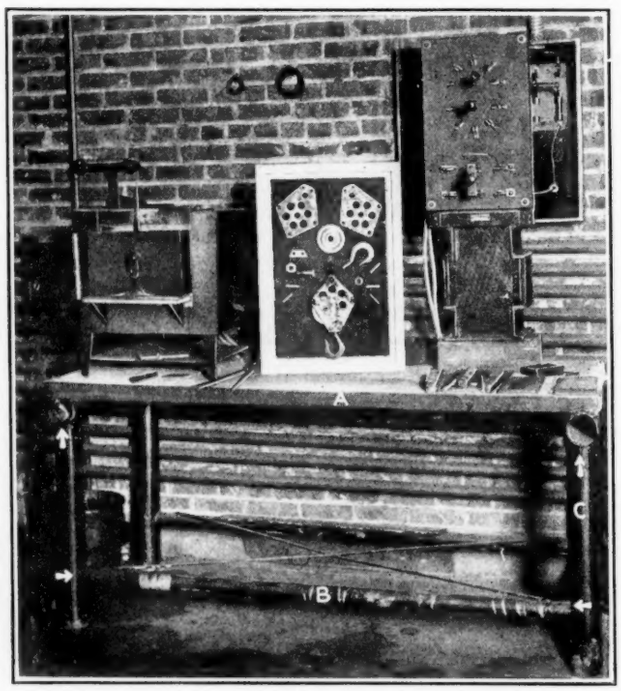


Fig. 3—A table made for the heat-treating furnace at the engineering shops. The only tool used for the iron work was the oxy-acetylene torch. The table top is reinforced concrete. The arrows indicate the welds. A = angle iron; B = 1- and 1¼-in. pipe; C = old boiler tube

flame over these parts as the weld progresses. Cool slowly by covering with asbestos. For long welds, the tacking method is used—that is, welding an inch in length and 3 or 4 in. apart, then going back over and welding between tacks, choosing the coolest section each time. This will work with steel and with cast iron if the line of the weld is not too long. If the piece is too large or intricate, a furnace must be built (brick makes a good one) and the piece heated with charcoal or kerosene torches to about 800 deg. F. The weld is then made and the piece reheated and covered air tight, as nearly as possible, to cool. The correct preheating temperature varies so much with the weight and shape of the piece that no accurate temperature can be given for all cases.

Preheating is often done merely to save gas in welding, and when this is the purpose, any means of heating to the desired temperature can be used, although hardwood charcoal is the best for all purposes and the furnace is not needed. The object of preheating all of the casting to a uniform temperature is to reduce contraction strains. Keep in mind that too high temperature may warp the piece.

The Cutting Torch

A special torch for cutting generally is used, although there are combination torches, one serving for both welding and cutting, the only change being a different tip. Some of these combination torches are of the low-pressure type, using only ¾ up to 7 lb. pressure for the large tip, with equal pressures on both sides of the torch. It will be of interest to cite that torches are now made for using many gases in addition to acetylene and hydrogen, such as carbo-hydrogen, Wolfe gas, Pintsch gas, city gas, butane gas, Calorene and Blau gas.

The cutting torch is similar to the welding torch, with the addition of an oxygen jet controlled by a lever valve convenient to the hand. The torch is lighted and the adjustment of the flame and the size of the tip used are the same as when preparing to weld, except for the oxygen pressure, which is carried at about 20 lb., depending upon the thickness of the piece. With the cone of the heating flame just touching the metal, the latter is brought up to a red heat, then the auxiliary oxygen is turned on and the cutting progresses rapidly and without stopping unless paint or rust scale is encountered. This will stop the cutting until the rust is melted or the dirt and paint are removed. If the piece is very rusty or the surface painted, the line of cut should be cleaned.

Cutting of cast iron is a little more difficult than the cutting of steel and the handling of the torch is more important. In fact, the method of procedure is nearly the reverse, as the preheating flame envelope is thrown back from the direction of the cut instead of toward the line of the cut, as with steel. When the metal melts, the auxiliary oxygen is turned on and by moving the torch back and forth over the line, the metal is alternately heated and cut.

Action of Cutting Explained

The action of cutting is one of oxidation. The combination of steel with oxygen when the metal is at a high temperature is rapid, and the metal is burned away by the jet of pure oxygen. The slag blows out of the cut from the force of the oxygen jet. Cutting is easy to learn, the principal requirements being a steady hand and care in keeping the cut clear of slag by holding the torch in such a position that the slag will be blown out.

Uses the writer has found for the cutting torch are: Cutting holes in pipe for the taking off of branch lines, the cutting of pipe for switchboard frames, sheet iron for repairs to coal cars and ash carriers, cutting out boiler tubes and beveling pieces in preparation for welding. Not many hacksaw blades are used up, as the cutting torch is so much quicker and easier. Often a cutting torch will pay for itself in one day; the ratio of cutting speed to hand work is as twenty minutes for one man to two days for two men.

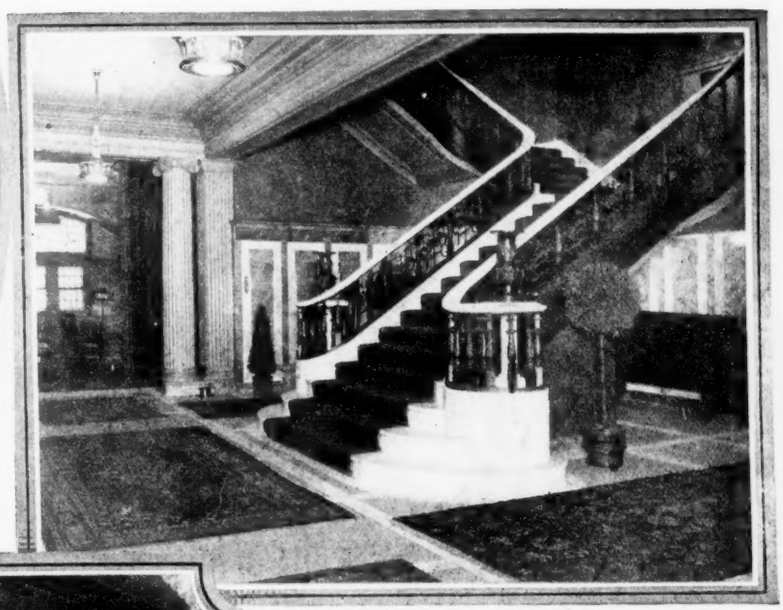
A future article will give costs of equipment, actual savings that have been made in using the torch, various things that can be made for the plant from junk found around any plant and answers to inquiries on previous articles that may have come in from readers.

In and Out of the Engineers Clubs

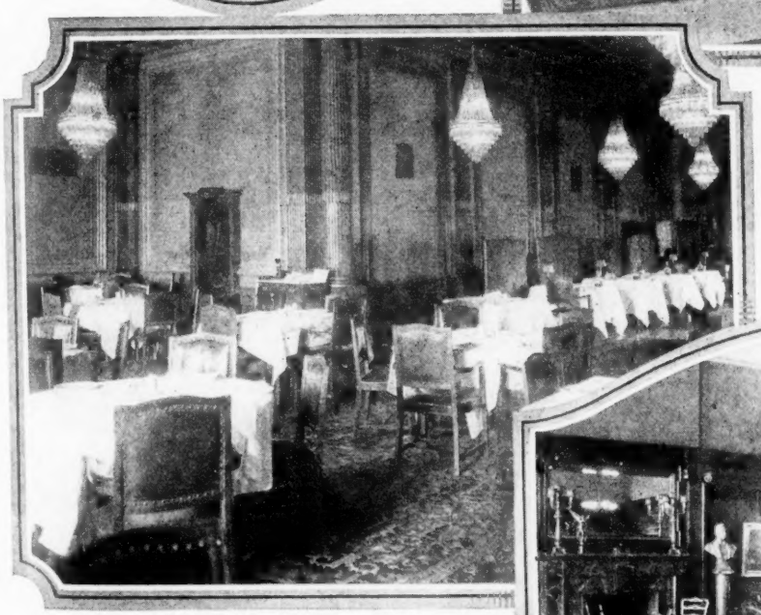
Where Good-Fellowship Cements Professional Ties

The four photographs on this page can do no more than suggest the quiet charm and dignity of the Engineers Club of New York City

Left—The Club stands on Fortieth Street near Fifth Avenue and faces Bryant Park. It is back-to-back with the Engineering Societies Building on Thirty-ninth Street

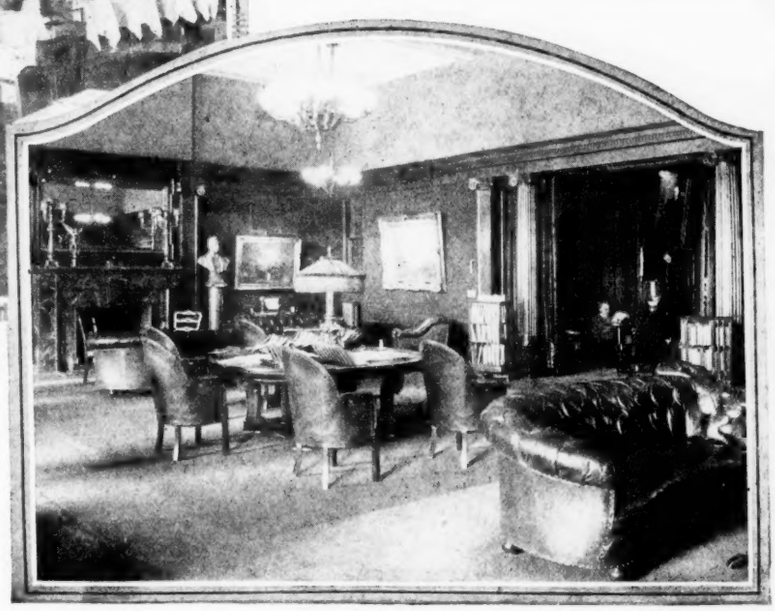


Above—Main staircase from lobby to second-floor lounge

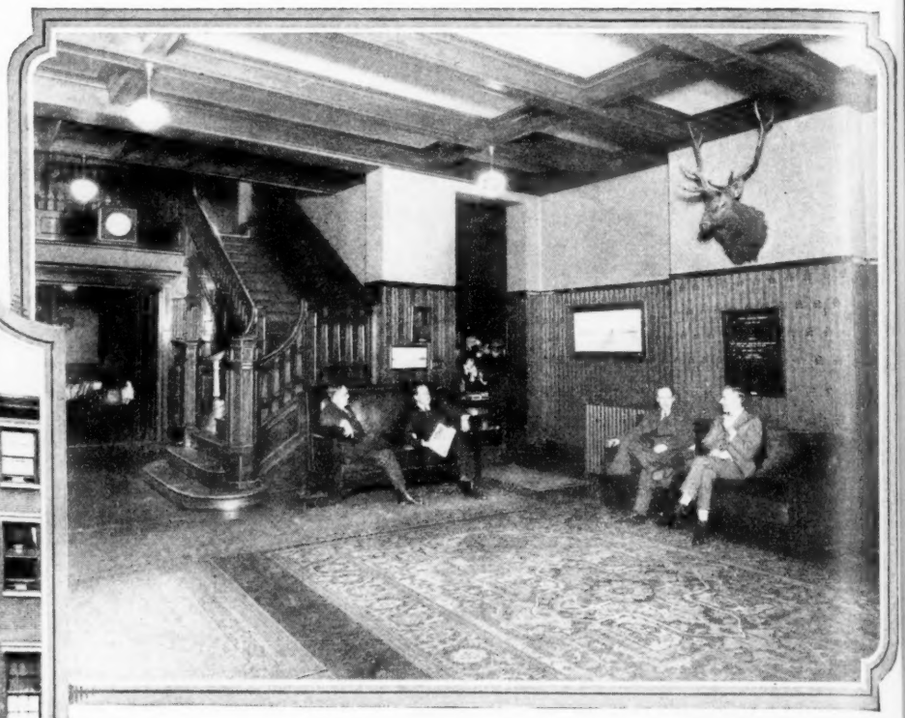


Above—Main dining room on the eleventh floor. In addition there is a large breakfast room on the tenth floor, a grill on the main floor and several small private dining rooms

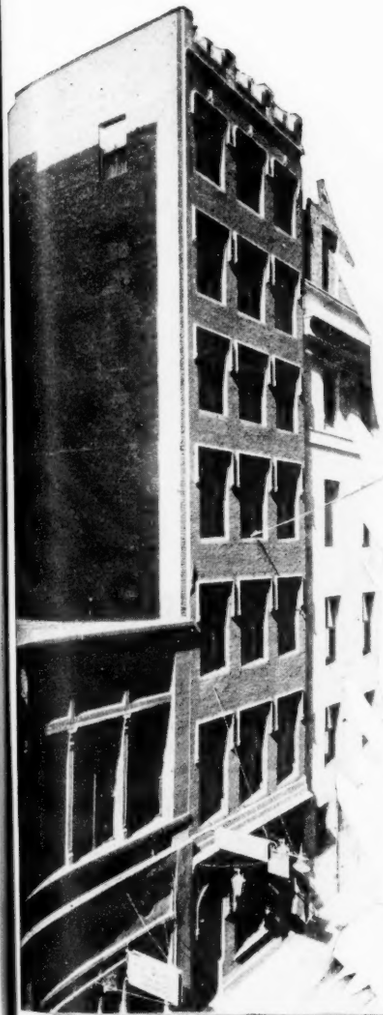
Below—Second-floor lounge. There is another lounge on the main floor



Right and below—The Philadelphia Engineers Club is undermining that city's reputation for conservatism by a membership growth which is taxing the capacity of the present building at 1317 Spruce Street



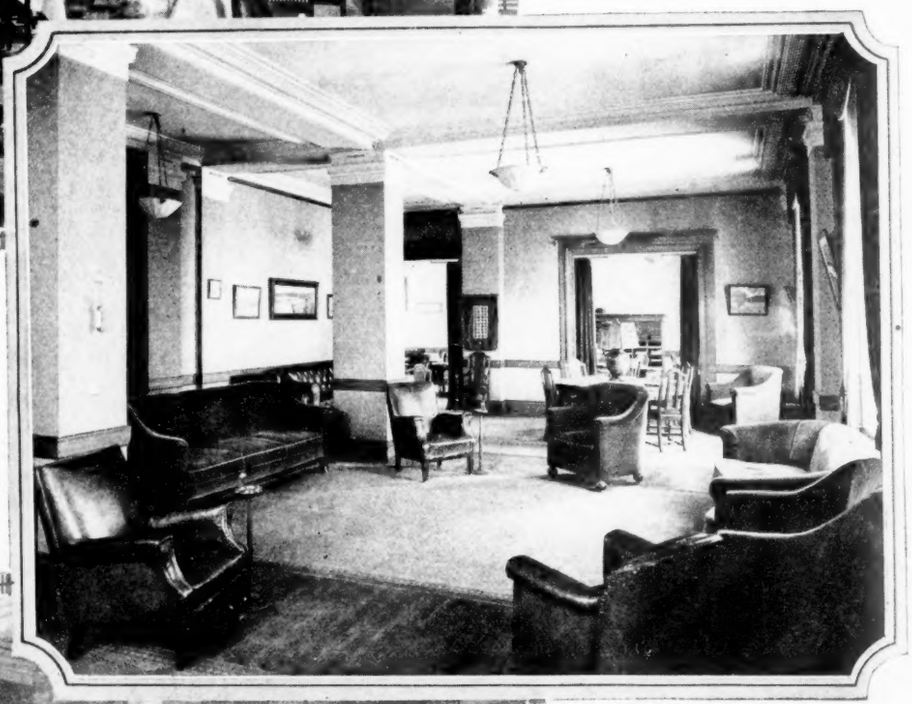
Left and above—With these new quarters at Six West Fayette Street, the Engineers Club of Baltimore is better prepared than ever to extend the proverbial Southern hospitality



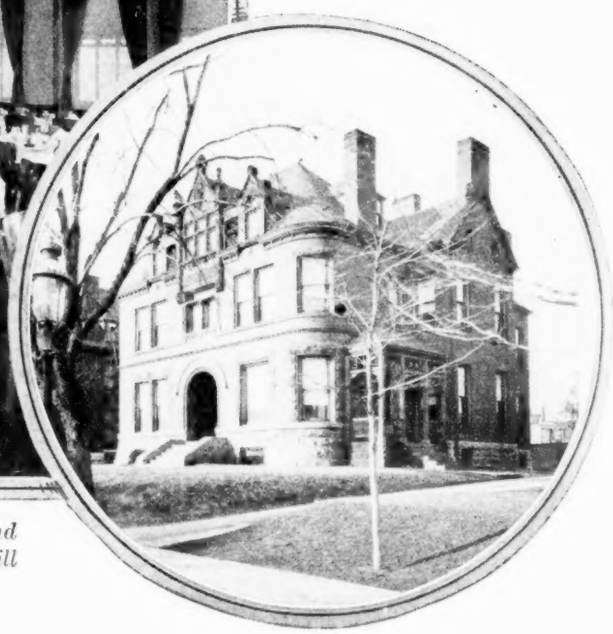
Left and above—Trophies of the hunt, silver cups and a ship's model over the fireplace give a sporting atmosphere to the lounge of the Chicago Engineers Club on South Federal Street

Left and above—The engineers of Dayton, Ohio, may well be proud of their new club house. It is one more proof that engineers appreciate beauty as well as utility

Left—The Engineers Club of Boston boasts a ladies' dining room beautifully decorated in the quiet colonial style which befits the New England metropolis. Improvements recently made include also a new ladies dressing room and rooms for billiards and cards



Right and below—Dignity, utility and comfort characterize the quarters of the San Francisco Engineers Club



Right—This fine old mansion, for the purchase and alteration of which a $50,000 fund is being raised, will be the new home of the St. Louis Engineers Club

A Steam Engineer Gets Acquainted with a Diesel Engine

By M. L. BLACK

WHILE the engineer in charge of a Diesel plant has duties that are somewhat different from those that the steam engineer is called upon to perform, essentially the differences are not great—both must keep the plant machinery in working condition. A steam engineer need have no fear of not being able to handle an oil-engine plant. Of course he must first learn the general principles of the engine, but the details of the machine will speedily be mastered by daily attendance.

In my own case, if you will permit a personal note to be introduced, I had had many years of operating experience both as watch engineer and as chief engineer of steam power plants, when the management of the plant of which I am now in charge, proposed that a Diesel engine be installed. The factory had use for but a small amount of steam during the summer, but during the winter all the exhaust of a 300-hp. four-valve engine was put into the heating system.

The power plant was wedged in among the factory buildings, and when more power became necessary, it was impossible to install another boiler and a second engine unless a new building be erected outside the factory. The land value, as is the case around any large city, was high and, together with the expense of moving the existing steam plant, made the plan inadvisable.

Cost of a Diesel Plant

At this juncture the plan of installing a 400-hp. Diesel engine in the existing engine room was broached. Investigation revealed that the engine together with generator, exciter, switchboard panel, foundation, etc., could be put in for $33,000. This, when compared with $27,000 for a steam engine, boiler, etc., did not seem as placing the Diesel out of question. The operating cost of the oil engine was the deciding feature, for we were guaranteed 10 kilowatt-hours per gallon of oil, costing 5 cents, and not less than 1,000 kilowatt-hours per gallon of lubricating oil.

The plan was examined from every point, and we estimated that we should be able to develop the additional power we needed at a cost of not over 1½ cents per kilowatt-hour, including fixed charges. It was the hope that by operating the old steam engine with just enough load to supply the heating requirements, the unit power cost of the entire plant would be less than with the steam plant.

I must confess that I saw the Diesel being erected with considerable trepidation. Here was I, a good steam engineer, getting ready to commit hari-kari. What did I know about oil engines? Although showing the world a stiff upper lip, in my heart I knew the answer was—"Not a thing."

What made things worse was the manager's habit of coming around the engine room and saying, "Mike, we're showing our faith in you by buying the Diesel as you suggested." Another favorite expression was, "Do you think you can make it run?" Then the president would drop in and say, "Black, I hope you haven't made a mistake in forcing us to go against our better judgment." After a few of these cheerful expressions I would go home feeling as if my days were numbered: The fact was that I had never recommended the purchase of the oil engine. True, the novelty of the idea attracted me, but I had never voiced my inner desires. In spite of my cunning here I was being saddled with the responsibility. If the engine fell down—"Black showed poor judgment in the purchase," so they would complain. If it was a success, each would say—"Black, your fears were not justified." In other words all preparations had been made to make me the "goat."

The more I thought of it the more determined I became to "see it through with Mr. Brittling." As a consequence I almost lived with the builders' erecting man and gained a good knowledge of the way the machine was put together.

More Information Needed

Here I wish to voice the sentiment I know is felt by 90 per cent of the operating engineers. I raise an objection to the attitude of the average erecting engineer. For some reason he explains as little as he can. A question is answered by the lifting of an eyebrow or a superior smile. He wraps the mantle of mystery about the machine his employers have unloaded on the customer—why? My opinion is that it is because he does not know the machine himself. Most of these erectors are shop mechanics—not machinists but handy men—they can put the parts together, *when properly marked*, but as to the Diesel's scheme of operation they know as much as I do of Sanscrit or Zulu.

The man we had was good, as erectors run, but I noticed that in case of a little trouble, say a valve chatter, he never knew immediately what to do, but tried this and tried that until the whole list of possible causes was exhausted—by that time the valve stopped chattering of its own accord.

After the machine was erected and put into serivce, the erector stayed three days and then left suddenly to go to another job. Consequently, I was then left in charge of the engine and felt as does a bachelor who finds a six weeks' old baby on his hands. To make the situation more realistic, in dropped the president, who, to show he was human, happily declared, "That Diesel is some baby!"

It was no use for me to deny parentage—it was up to me to raise it properly and see it kept out of trouble.

Seriously, the first few weeks were filled with worry. Little actual trouble occurred, but I was always afraid something was going to happen. This soon wore off and we speedily began to understand the machine and to admire its reliability, simplicity and economy.

At present the Diesel is kept in operation for approximately 300 days, for 9 hours per day. The steam engine is run during the heating season approximately 200

days, and during this period the Diesel has a load of about 200 hp., but in summer its load is close to its rated capacity, 400 horsepower.

In the steam plant there is a fireman who during the winter fires the boiler and in summer keeps a fire under a small hot-water boiler, in which is burned waste paper, etc. His other duties in summer consist of keeping the flower beds in condition, cutting a small plot of grass, etc. In the engine room we have a watch engineer and a helper during the daytime, and at night we have a man who keeps steam up in the boiler in winter, attends to the hot-water-return pumps, operates a 10-kw. high-speed engine lighting set which is run in winter. In the summer these lights are supplied by a storage battery, charged during the day by the Diesel set. The day engineer and oiler and fireman report for duty at 6:30 a.m. In winter the oiler attends the steam engine and gets it ready to start. The engineer goes over the Diesel, oils it, etc., and at 6:30 the steam engine is started and almost immediately the oil engine is started up.

Only One Operator Used

In starting the oil engine, we found that only one attendant was necessary. The engineer bars the engine over for one complete revolution before starting. This is to detect the presence of water or any loose part in the cylinder, etc. He then bars the engine to the starting position, at which point the starting air will enter the cylinders having the air-starter valve gear.

He then opens up the oil bypass on the fuel valves and gives the engine's fuel pump a few hand strokes, enough to cause the oil lines to fill and overflow through the bypass. The bypasses are then closed and two more strokes given the pump. The next step is to open the air injection bottle to admit air to the fuel valve. The air starter bottle is then opened and the engine turns over. As soon as a cylinder starts firing, the air starter gear is thrown out and the fuel valves of these cylinders brought into gear. The engine at once comes up to speed and is ready to have its load. The engineer lets it run for, say, one minute without load, observing that the cooling water is flowing, the force-feed oilers in operation, etc.

He then steps to the switchboard, builds up the voltage in the exciter, closes the generator field switch and builds up the generator voltage. The steam engine is in operation and the Diesel must be paralleled. To do this we have a synchroscope and a governor control at the switchboard, so it is quite an easy matter to get the frequency correct and to put the machines in phase.

Plant Log a Necessity

To insure proper attention to the engine we found a log necessary. On this log the engineer at each hour sets down the exhaust temperature of each cylinder, the cooling-water inlet and exit temperatures, the temperature of the main bearings, the fuel-tank level, the room temperature, the switchboard-instrument readings, etc. If oil is added to the circulating system the amount is noted. The main bearings have thermocouples placed in the bottom shells, and the reading of the dial at once reveals any hot bearings. I believe this device should be on every engine, although ours is the only installation of which I have information. On the log sheet note is made of any unusual sounds, temperatures, etc. In this way trouble can be detected early. If the engine is overhauled or any adjustment made, notation of the event is set down.

This log sheet permits us to figure each day the cost of making power, and we find the machine doing better than the builder claimed.

In establishing a plan of maintenance, we determined to make a schedule of adjustment which called for the removal of all four pistons once every six months. I now believe once a year is ample. Some plants pull a piston every three months, so that in a year all are pulled once. I believe that the better plan is to pull all the pistons at the same time. It is possible to shut down Saturday at noon, go home, and return at 6 p.m. when the engine is cool. By working all night the four pistons can be pulled, rings cleaned, connecting-rod bearings adjusted and the parts all put back by, say, 6 a.m. Sunday. Since this is done only once a year, the men are quite willing. In addition, if but one piston is pulled, the men will dally around and take just as much time. I make it a practice now to do this in the fall after the boiler is under steam. If any trouble develops, we can run the steam engine. The fireman, the oiler and the engineer, along with myself, do the work. This means that the fireman must work all night, but to adjust the hours I let the fireman go home at 6 a.m. and keep the oiler until noon to watch the boiler, after which the night man comes on duty and stays until Monday morning. This entails overtime, for which we pay the men double for all overtime.

Maintenance Schedule

The engine admission valves are removed every eight months and the exhaust valves every four months, one each being removed on the afternoon of the last Saturday in each month.

The fuel valves are also examined every four months. It is my opinion that with clean oil once every nine months is ample, but our fuel is 22 deg. Baumé and is often dirty.

Our circulating lubrication system has a centrifugal and a gravity oil purifier. The oil passes continuously through the filter bags of the gravity filter, and once a week we run the centrifugal to eliminate water, etc. It is my opinion that both should be run continuously, with a bypass, so that the centrifugal purifier can be cleaned.

So far, after four years of service, the main bearings have not been renewed. We check the wear once a year and remove enough shims to make the top clearance correct. The lower shells wear unevenly, and this is corrected by scraping, using a micrometer to make the shell thicknesses all the same.

Contrary to expectations the air compressor has caused but little trouble. So far only two valves have broken and no carbon exists. This is due to our following the builder's instructions as to the amount of oil to be fed the compressor.

Before leaving the subject of duties, I wish to stress the desirability of keeping the engine clean. The operator should be compelled to remove all oil stains and drips. The floor should be painted red or gray and ordered to be kept clean. I make it a rule to rub the railings, engine frames, etc., with my hand each day—if I find dirt or oil someone is in trouble.

By instilling in the operator's brain the idea that the engine must be kept spotless, he gains the impression that it must be valuable and so sees that the working parts are in shape.

Greensboro Water-Works Adds Turbine-Driven Pumps

Like so many Southern cities, Greensboro, N. C., has experienced a tremendous expansion. This increased the water demand beyond the capacity of the old water-works and forced the installation of newer and larger pumping units.

ALTHOUGH Greensboro, N. C., has long had a water-works of some description, the present pumping plant was installed in 1911. The machinery purchased at that time consisted of a 2,000,000-gal.-per-day slide-valve, cross-compound, horizontal crank-and-flywheel pumping engine and a second unit of the same capacity but equipped with Corliss-valved steam cylinders, both operated condensing, and obtained steam from two 72-in. x 18-ft. horizontal return-tubular boilers.

Increased growth of the town prompted installation in 1923 of a 4,000,000-gal. series centrifugal pump designed to operate against a total head of 310 ft. and connected through gearing to a steam turbine. The two pump casings are placed in series and are mounted on a common shaft. In 1925 a 6,000,000-gal. series centrifugal pump built for 310 ft. head and driven by a geared steam turbine was installed. Both these turbines are served by surface condensers of the water-works suction type, the condensers being placed in the suction lines to the pumps, so that the water handled by the pumps serves as cooling water for the condensers. Both condensers are provided with Edwards air pumps. A 2,500-sq.ft. horizontal water-tube boiler built for 150 lb. working pressure was added to meet the increased steam demand. The sliding-valve pumping engine was junked and the larger turbine set in its place.

The former pumping engine was in excellent mechanical condition, but owing to its high steam rate, caused in part by its valve design, no customer could be found that could be persuaded to consider it as anything but scrap. This event indicates, so the officials feel, that a fairly high depreciation charge should be set against water-works machinery to meet the competition of the more economical designs of the future. It is now planned to junk the second pumping engine and replace it with a turbine-driven centrifugal unit of the general type of those now in the plant.

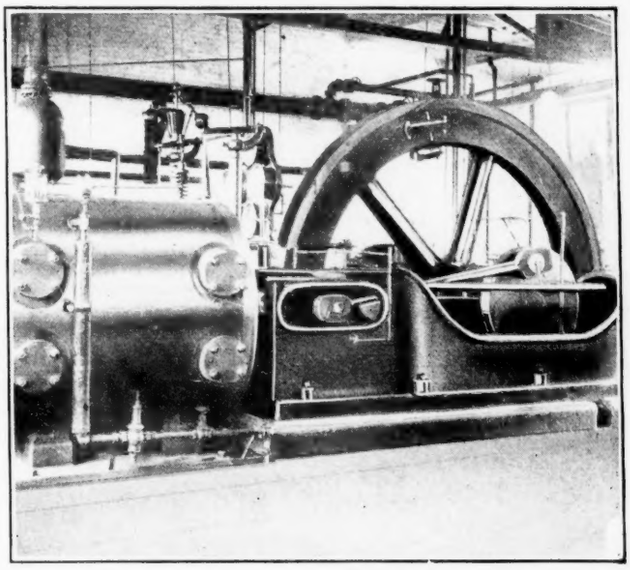


Fig. 2—Corliss cross-compound pumping engine to be replaced by a centrifugal pump

An open heater is used to raise the condensate temperature to about 200 deg. F. Formerly live heat was used for this heating, but after the installation of the second centrifugal pump the exhaust of the air pumps was led to the heater, along with the exhaust from the boiler-feed pump. The condensate from the crank-and-flywheel pumping engines was formerly passed through a filter press before entering the heater, for the purpose of eliminating the lubricating oil carried over into the condenser. The exhaust from the Edwards air pumps is now put through this filter. The boiler-feed water is at present handled by a 7x4½x10-in. outside end-packed duplex steam-driven pump, but this will shortly be replaced by a turbine-driven centrifugal pump and the duplex unit used as a stand-by, for which service a 6x4x6-in. duplex steam pump is now being used.

This station receives the city water from the filter beds

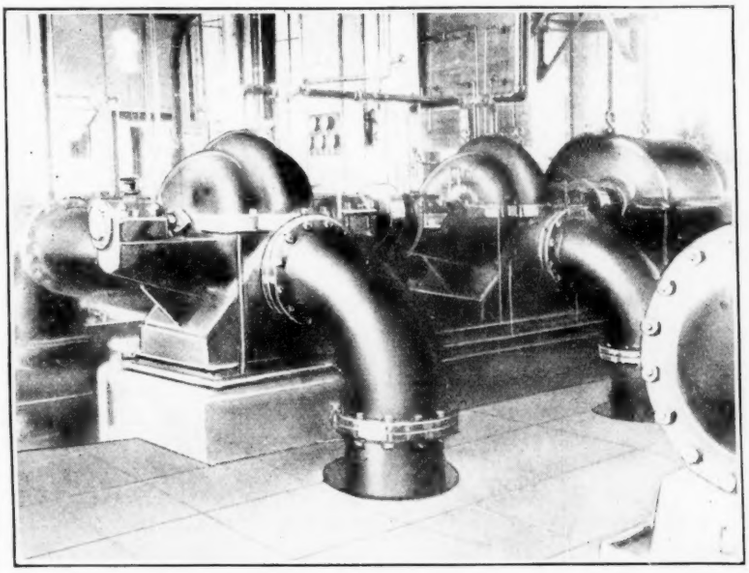


Fig. 1—Pump end of 6,000,000-gal. DeLaval turbo-pump installed in 1925

and discharges it into the city mains. The source of the water supply is the Ready Fork River, about eight miles from town, where a five square mile watershed is under supervision to insure sanitary conditions. At the river station there are two 2,500-cu.ft. water-tube boilers supplying steam to a 4,500,000-gal. and a 7,500,000-gal. turbine-driven centrifugal pump. In addition there is a vertical waterwheel, chain-driven to a third centrifugal pump. As long as water from the reservoir is escaping over the spillway, giving a head of about 25 ft., the waterwheel is kept in operation.

The plants have lately been equipped with recording steam and water-pressure gages, as well as CO_2 recording instruments. At present for each 1,000,000-gal. water pump 12 lb. of coal is used per foot head. This is a net thermal efficiency of approximately 7 per cent.

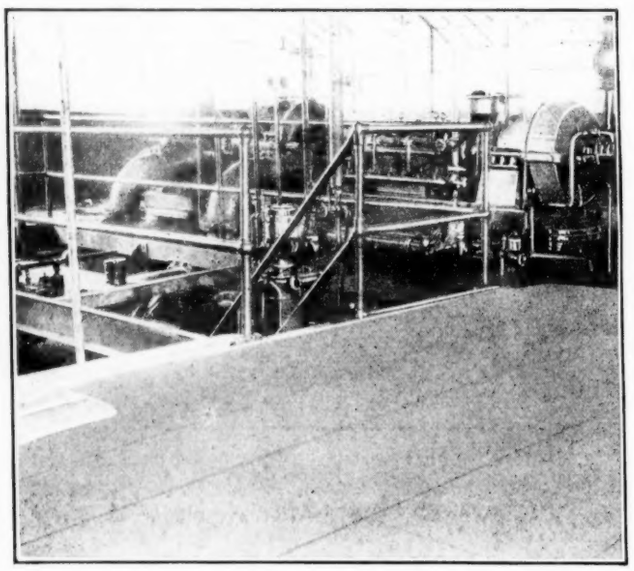


Fig. 3—4,000,000-gal. series centrifugal pump driven by steam turbine

The investments in the two plants are carried on the city's books as follows: River plant, $187,000; high-pressure plant, $137,000. The outstanding bonds against the water-works system, including the sanitary sewers, is $1,500,000 and the income from the water rentals is such that the bonds are being taken care of when due.

The water rates are:

First 1,500 cu.ft., per 100 cu.ft., 25.0c.
Between 1,500 and 7,000 cu.ft., per 100 cu.ft., 22.5c.
Between 7,000 and 14,000 cu.ft., per 100 cu.ft., 19.0c.
Between 14,000 and 33,000 cu.ft., per 100 cu.ft., 15.0c.
Between 33,000 and 66,000 cu.ft., per 100 cu.ft., 11.0c.
Between 66,000 and 133,000 cu.ft., per 100 cu.ft., 9.0c.
From 133,000 up, per 100 cu.ft., 9.0c.

These rates compare favorably with those in other Southern cities. The municipality has 978 hydrants on which no charge is made for water either for street flushing or fire protection.

The demands of oil engines, especially those of high power, require a wide range of pressures, speeds, temperatures and materials, and it is important that the proper oil be used. Lubricating difficulties in these engines are usually due to failure of the moving parts to get oil, too rapid breaking of the oil film, or dirty oil.

Engineering One's Finances

BY CHARLES H. HERTER

The amount of advice an engineer can use is unlimited. From the first day he goes to school until he lays down his wrench or pencil for the last time, he is continually absorbing information, so as to be prepared for all eventualities. By far the greater part of his energy is devoted to the mastery of engineering problems, and his earning capacity in a large measure is dependent upon his skill in "harnessing the forces of nature to the will of man."

As one grows older, the fact is recognized that it is not sufficient to be able to make money—it is just as necessary to conserve one's resources for the period when one's earning capacity is diminishing, to make sure of never becoming a burden to one's family or to the state.

In these times of hurried living, and ever conscious of this need of providing for an unknown future, an engineer is prone to accept advice which, instead of happiness, will bring him grief and rob him of the fruit of many years of labor.

This is likely to happen when our busy engineer falls into the hands of some poor but apparently deserving inventor, who will gain the engineer's confidence and support by telling him how hard he has been working toward the perfection of a method for generating electricity direct from coal, for building non-sinkable ships, for burning oil and hydrogen with an efficiency of 95 per cent, for making leather resistive to all destructive agencies, or for developing a permanently automatic household refrigerating machine.

WORKING ON THE PROSPECT

The inventor complains that people appear to have no conception of the rapid strides being made today by engineers whose greatness will be recognized only hereafter, but it pleases him to have found in the person of the listener the one man who does seem to understand him fully and who certainly evidences good judgment by agreeing (sooner or later) to accept a share with him in the long sought-for opportunity to get in on the ground floor of a great money-making proposition.

The inventor who thus represents himself as suffering hardships for the ultimate benefit of all mankind, usually seeks the acquaintance of men who are honest and upright, because he knows from experience that such men expect others to be just as honest and unsuspecting. If necessary, he cites cases where the successful exploitation of a clever idea has brought wealth and fame to the man who knew enough to take a chance at the right time.

Engineers, who may be well informed on the properties of all sorts of materials and on natural physical laws, may not know human nature well enough, and therefore fall an easy prey to such impostors. One ought not to get caught in the trap, but it has happened to the writer several times, and all that he got out of his experience is the determination to be on his guard in future and to warn fellow engineers to be more careful and not to risk money unless advice has been obtained from the editor of his trade paper, the president of his association, or from his other associates, his wife included, before he allows himself to be pumped down to 29 inches of vacuum—and then have to begin all over again.

Lubrication Research Needed

IN OPERATING oil engines certain lubrication troubles are at times encountered which are most difficult of solution, and it would be well if one of the oil-research organizations were to spend some time on these problems.

It has been found that upon a change of fuel from a filtered oil to one carrying a considerable percentage of sulphur, serious operating conditions are experienced, the rings become gummed or carbonized, resulting in considerable piston blowing and at times burning or scoring of the liner.

Apparently, the fuel oil is, in itself, not the immediate cause, and inasmuch as the lubricating oil has been satisfactory, one hesitates to attribute the trouble to faulty lubrication. Nevertheless, observation tends to substantiate the claim that the sulphur content of the fuel oil somehow reacts upon the lubricating oil to render the latter unsuitable and insufficient as a lubricant, and in addition causes the heavier part of the lubricating oil to deposit as an asphaltum or tarry mass.

Proper research might result in a standardization of lubricating oil properties to be avoided when a sulphurous fuel oil is used, or a recommendation of the change in the grade of the lubrication necessary with an increase in sulphur content of the fuel oil.

Narragansett's Unusual Layout

THIS issue will find many of *Power's* readers at the A.S.M.E. Spring meeting in Providence. On Tuesday afternoon they will have an opportunity to visit the enlarged South Street Station of the Narragansett Electric Lighting Company, described in the leading article. There are larger stations to be seen, but none more interesting. The plant is unique, or at least unusual, in several respects.

In these days it is of interest to discover a large central station equipped entirely with jet condensers. That serving the new 35,000-kw. unit is the largest single-body jet condenser in the world. Corrosive condensing water is the explanation. This has introduced other problems, chief of which is that of purifying the high percentage of makeup required with jet-condenser operation. The Providence city-water supply used for makeup is unusually soft, but no chances can be taken with the feed supply of boilers operated at high ratings and with high furnace temperatures. So an enormous hot-process softener has been installed, with space left for another like it.

But this is not all, the desire to operate the new section of the station at higher steam pressure and temperature, and at the same time tie the old and new sections together, was ingeniously satisfied by the use of a large reducing valve and desuperheater connecting the new steam mains with the old.

The tie-in does not stop with the steam mains, but extends to the heat-recovery cycle, where the effort to give the whole station the advantages of recent advances in the art of stage heating has resulted in a novel heat-balance layout. As much as sixty per cent of the throttle steam may be bled from the new turbine, furnishing much of the heat for the feed supply of the entire station.

The South Street Station exemplifies three methods of firing—oil, stokers and pulverized fuel. It is true that oil is not being burned at present on account of its high price, but some of the furnaces are equipped to use it on short notice in an emergency.

Finally, no visitor can fail to be interested in the four large new boilers, which burn pulverized fuel and are provided with three different types of air preheaters. One of the boilers is equipped with special drum, connections and meters to determine what fraction of the total steam produced is made in the water screens.

Taking it all in all, the operation of this station bids fair to furnish data of great value to the engineering profession.

The Executive's Interest in the Industrial Power Plant

POWER cost, in the average industry, represents such a small part of the total cost of production that there has been a tendency in many instances to neglect this part of the enterprise, at least until something happens to show that thousands of dollars per year are being wasted that could be saved by a little interest on the part of the company executives. It has been frequently asserted that the time of an executive in a large industry is more valuable when applied to those problems intimately connected with production and distribution than to the generation of power in an isolated plant. This probably is true if the executive is going to attempt to run the power plant. However, operation of the power plant is the job of a competent engineer, and any executive who tries to take such a responsibility is probably borrowing a lot of trouble that he could profitably avoid.

Before any plant can be run efficiently it must be of a design suited to the industry it serves and be equipped to obtain an intelligent record of its operation. Then it is essential to know what the plant can do when in good condition and properly operated. After this about all the executive need to know about the plant's operation, can be given to him weekly or monthly on a simple report that shows how closely the plant is being run to standard. If costs are going up, it will be up to the chief engineer to explain the cause. The consideration of such a report will require but a half hour or so and can well be made one of the things discussed at the monthly or weekly meeting of the department heads, of which the chief engineer should be one. Such meth-

ods are applied in many instances where the executives of large industries have found that the savings made in the operation of their power plant was among the important contributions to their company. The power cost may represent only two or three per cent of the total cost of production, but in a large industry this may run into hundreds of thousands of dollars per year, something that possesses great possibilities of savings or waste, depending upon how intelligently this problem is handled.

Tolerances in Testing

IN CONNECTION with the meetings of the International Electrotechnical Commission there was considerable discussion of the subject of tolerances to be used in comparing the performance of hydraulic and steam turbines with the manufacturers' guarantees. For some time it has been the practice in European countries to allow a tolerance of the order of two per cent, so that if an hydraulic turbine is guaranteed for ninety-three per cent efficiency, and actually develops ninety-one on test, it is deemed to have met its guarantees.

There appears to be some confusion of ideas with respect to tolerances and accuracy. It is argued, quite properly, that no test of a steam or hydraulic turbine is free from error, and it is pointed out that the result of any such test may be one or two per cent higher or lower than the truth. This may readily be admitted; in fact, in the absence of elaborate precautions it is probable that the deviation may be somewhat greater than this. This, however, is something that the manufacturer must take into account in stating his guarantees. He naturally calculates the expected performance of the machine and then states a guarantee sufficiently poorer than his expectations, on the basis of his judgment and experience, to cover variations in testing, uncertainties in design and inaccuracies in construction. Variations in operating conditions from those specified in the guarantee are usually cared for by the application of corrections established by the manufacturer, or by special tests.

If in addition to this, the manufacturer is allowed a tolerance in meeting the guarantee, he will simply make his guarantee better by the amount of the tolerance. This has a tendency to encourage the introduction of larger guarantee values in the literature. While it is possible that such values may be more nearly representative of the actual expectations of the manufacturer, and perhaps of the actual performance of the machine, there is no certainty that such correspondence would be any better than it is today, and the publication of test results will in any case make available to the engineering profession the actual performance of machines as accurately as it is possible to determine it. Any engineer investigating steam or hydraulic turbine performance is interested, not in guarantee figures, but in test results.

The use of tolerances in manufacturing industries has perhaps confused the issue somewhat. There seems to be a tendency to assume that conditions are analogous, which really are not so. Suppose, for example, that a purchaser orders from a manufacturer a number of end gage rods to be precisely one foot long. No manufacturer of gages would accept such an order, because it is unthinkable that a number of rods could be made at any reasonable cost, of any precise length. The manufacturer will demand that the purchaser allow him tolerances, even though these tolerances be very small. The businesslike way of specifying end gages of this nature is 12.0000 $\pm$ 0.0001 in., or in some similar way.

But now assume that the object of the purchaser is somewhat different, and that he specifies solid gold bars so sized that not one of them is shorter than 12.0000 in. Inasmuch as these bars are made of gold, there is no danger that the manufacturer will make them excessively long, but to meet the specification and avoid rejections, he must see to it that not one of the bars is shorter than the stated minimum length. No tolerance whatever is necessary in a case of this sort.

This second case is analogous to meeting the guarantees on a turbine. The guarantee is in effect a statement of the minimum efficiency (or the maximum steam consumption) that will be acceptable to the purchaser. A sensible manufacturer will of course see to it that his expectation is enough better than the specification or guarantee to give him at least a fair chance of a successful acceptance test. A tolerance is entirely unnecessary and merely confuses the issue.

Comprehensive Program of Stream Surveys Needed

THERE has been an ever-increasing need for information on rivers where power developments are to be made, to allow the consideration of a comprehensive plan of utilization. The lack of such data has been one of the handicaps under which the Federal Water Power Commission has labored. Although such studies have been made to a limited extent on some rivers, particularly on the Tennessee, no comprehensive national program of river surveys has been attempted. As an outgrowth of the agitation for legislation to devote license fees collected under the Water Power Act to a general survey of rivers on which power can be developed, a report has been submitted to Congress by the Chief of Engineers and the executive secretary of the Federal Water Power Commission, that the cost of such surveys will be approximately seven and one-half million dollars.

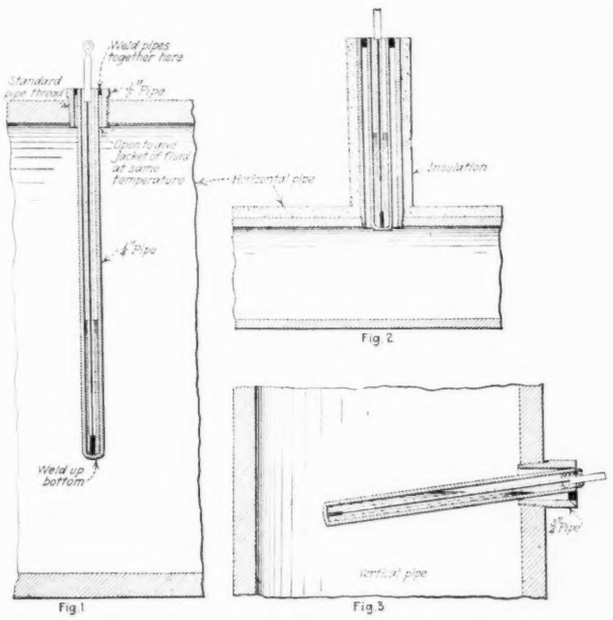
This may appear like a considerable expenditure for surveys, when looked at as such, but when compared with the value of the power on the rivers, the cost of these surveys becomes insignificant. When the water powers of this country are completely developed, it is estimated that they will produce two billion kilowatt-hours annually, which at three-tenths of a cent per kilowatt-hour is worth six hundred million dollars per year. In other words, the cost of these surveys has been placed at about one and a quarter per cent of one year's value of the water powers.

There are many other interests that these surveys would benefit, such as navigation, irrigation, municipal water supply and flood control. Leaving these out of the picture, the vast economic value of our water powers justifies the cost of obtaining the necessary data that will make possible utilizing them to the best advantage. The time required to make these surveys allows for providing the funds over a period of years and, as has been frequently pointed out by the Federal Water Power Commission, these surveys can be financed by the funds obtained from licenses for water-power development, without any direct demand upon the National Treasury.

Practical Ideas From Practical Men

Types of Thermometer Pockets

In taking temperatures where a thermometer well is required, it is important that the well be so constructed that there is the least possible time lag between the change in temperature of the substance measured and the change in temperature of the well,



Thermometer pockets designed to meet different conditions

also that there is the least possible loss from radiation, etc.

A thermometer well that will meet these requirements and is easily constructed at low cost, is shown in the illustration. Three different conditions that may be met with a pocket of this type are also shown.

As illustrated in Fig. 1, the well is constructed of two pieces of pipe welded together. A piece of ¼-in. pipe 9 in. long is welded up at the bottom to withstand pressure. Outside the top or open end of the ¼-in. pipe is a short piece of ½-in. pipe welded as shown at its top and threaded at its bottom end to screw into the main pipe. The ½-in. pipe is left open at the bottom so that the well proper will have complete submergence in the fluid; that is, the ½-in. pipe acts as a jacket.

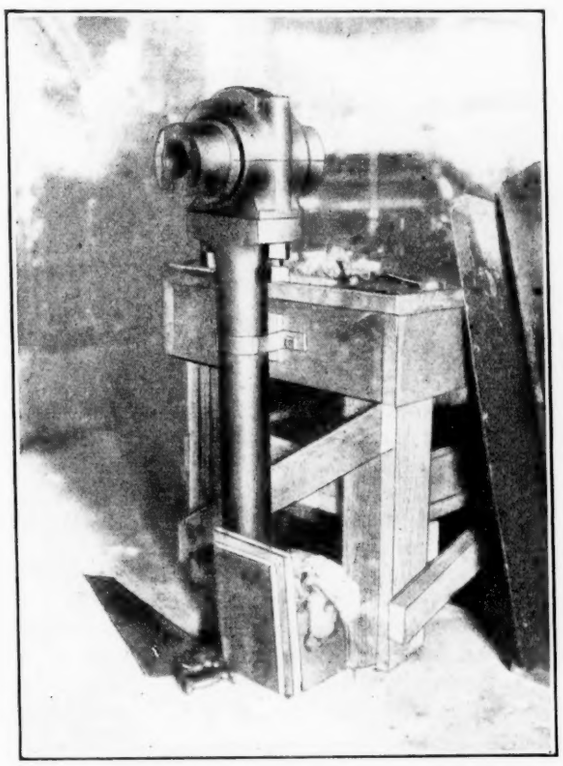
This feature of submergence is best exemplified in the sketch as shown in Fig. 2. Under this condition steam temperatures, for example, in a small line may be obtained without subjecting the line to an obstruction that might not be desirable, yet there will be sufficient circulation to maintain the full temperature in the well even though it is outside the main pipe. The well in this case should be insulated the same as the main line so that only a negligible amount of heat loss can take place.

Fig. 3 shows how the pocket is made for a vertical pipe. The outside pipe in this case is usually ¾ in. rather than ½, to give sufficient slope to the well to retain oil or other suitable liquid. The same general arrangement may be used, however, with regard to the reservoir for complete submergence in either a large or small diameter pipe. M. S. GARE.

Painesville, Ohio.

Fitting Rod Bearings

Fitting the piston and crankpin bearings of a Diesel connecting rod requires that the rod stand vertically. Inasmuch as the ends of the rod assembly are rounded,



Clamping connecting rod to bench while fitting bearing

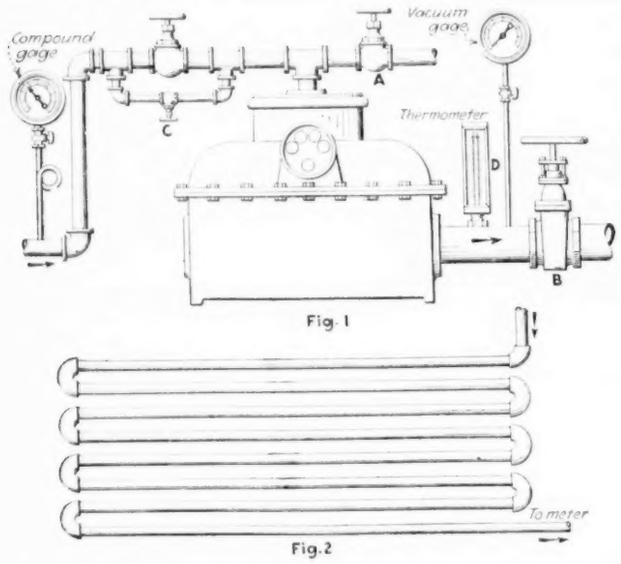
the job usually calls for the removal of the crank bearing when fitting the piston pin bearing.

The illustration shows how one engineer got around his difficulty. On the end of his workbench he attached a clamp by means of which the rod is held vertically with the bearing at a height suitable to permit scraping without fatigue. G. GROW.

St. Louis, Mo.

Why the Bills for Steam Were Low

A steam plant that sells steam to different buildings found the monthly bills less than they had been in previous year, so investigation was started to discover the cause. Steam was charged per 1,000 lb. registered by condensation meters. The steam was delivered to the buildings at 75 lb. pressure and a 10-in. vacuum is maintained on the return lines at the power plant. There are eighteen buildings in all connected to the



Arrangement of condensation meter connections and coil

heating system and the heating surface in each ranges from 1,000 to 20,000 sq.ft. In the small buildings it was found that steam was blowing through the meters. These were equipped with gravity heating systems, which worked all right when the vacuum traps functioned properly.

The illustration, Fig. 1, shows the general arrangements of meter and connections. The meter is of the two-bucket type, one emptying while the other is filling, each dump being registered by a counter. It will be apparent from the sketch that with a number of vacuum traps leaking, there is nothing to stop the steam from going through the meter without being recorded.

To find out if steam was blowing through, the inlet to the meter was disconnected and piped to blow to the atmosphere, as shown at *A*, and, sure enough, there was nothing but steam coming through from the system. The building owners were requested to put the vacuum traps in good working order and the bills were adjusted satisfactorily. One building containing 16,000 sq.ft. of radiation showed no steam coming back in the returns and was pronounced O.K. Still the meter readings did not correspond to the amount of steam that should be used to heat the building. One of the officials who thought the meter readings were at fault visited the building one afternoon. He found the meters flooded with water and not registering. The trick, it was discovered later, was to admit steam to the building until all the coils and radiators were hot and the returns coming back warm. Then the valve *B* in the discharge line from the meter would be closed until the vacuum gage showed 1 or 2 lb. pressure, then opened just enough to maintain that pressure. This changed the meter into a receiving tank and consequently prevented it functioning as a meter. Needless to say the valve *B* was removed.

The man in charge was quite indignant over its removal, as his intentions were not to cheat the meter, but to extract the heat from the steam, as he explained he did not want the returns going back at 195 deg., necessitating the use of cold water in the vacuum pump suction.

The type of vacuum trap used in this building opens to relieve the coil of condensation at a temperature of 206 deg. So he had the returns from the upper floors piped to coils in the bottom floor, as shown in Fig. 2, to condense any steam that would get past the vacuum traps. In the meantime a compound gage was installed ahead of the main return valve, which would then be choked after the building reached the proper temperature and the gage would indicate if the system was getting flooded. Later a ½-in. bypass was put around the valve as at *C*, the object being to lessen the velocity of the water ahead of the meter. The building uses 360 lb. of steam per square foot of radiation per season. The temperature of some of the floors, used for printing, has to be kept at 80 deg. The thermometer *D* in the discharge pipe from the meter is watched and the returns allowed to go back at 160 deg. and less in mild weather.

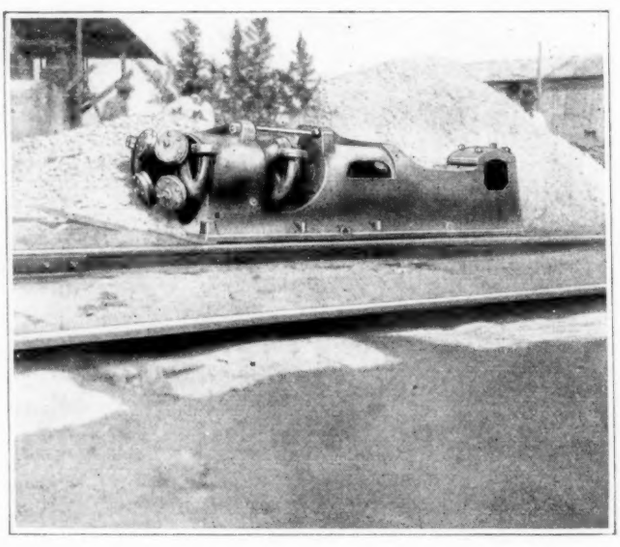
THOMAS SHEEHAN.

Springfield, Mass.

Mishandling Machinery

Visiting plants in the process of erection, one is struck by the lack of care used in the storing of machinery before installation.

In the illustration appears an example of the typical way machinery is mishandled in and around some Florida plants. The building and foundations of an ice



Compressor is half covered with rock

plant were not completed when the ammonia compressor arrived. To avoid demurrage, the compressor was thrown alongside a pile of crushed stone. Other loads were dumped alongside the machine until it became half covered with crushed stone. If the bearings, piston rod and other moving parts give trouble after the plant starts, the blame may be due to the total lack of appreciation of good machinery shown when the compressor was exposed in the fashion shown.

Jacksonville, Fla. CHARLES ST. JOHN.

Comments from Readers

Location of Blowoff Cock

In the "Questions and Answers" column of *Power*, March 23, the recommended locations of the blowoff cock and valve are in error. The cock should always be placed next to the boiler and the valve next to the blowoff line. To operate, the cock is first opened and blowing down done with the valve, which is then closed before the cock is closed. In this way the cock will always remain tight. The valve can be reseated and the stem packed while the boiler is in service.

The arrangement usually sent out by manufacturers of combination blowoff valves is correct. A valve will always leak with scaly water or sand and must be reseated, but the cock, being opened and closed in dead water, will always hold. BASIL S. T. DOBREE.

New Orleans, La.

Power Plant Engineers' Wages

The editorial entitled "Power Plant Engineers' Wages" in the March 23 issue opened up a phase of our economic structure that has been sadly neglected. The industrial fabric of the country will sooner or later suffer if the employers and engineers do not get closer together.

Collectively a cog in our economic gear, the operating engineers of industrial plants make up an indispensable part of the mechanism. These men are charged with the responsibility of producing more power than even the public utilities. When it comes to the responsibility of burning coal, there is only one group handling more of this precious raw material than the operating engineers—the locomotive engineers.

Four times as many engineers should belong to engineering associations as do. The employers could well afford to say: "We will pay your dues if you get into the game and work along this line."

The condition outlined in the editorial and resulting discussion is not prevalent to a large extent, but there is entirely too much of it. The controversy running through the power field between the central station on the one hand and the advocates of isolated plants on the other has greatly depreciated the importance in the public mind of the isolated power plant. At the same time the economic importance of the operating engineering profession in our business structure has been more or less overlooked.

The employer has paid no attention whatever to his power problems. The easiest way to get power has appeared to him the best way. The thermodynamics of his power problem have been all Greek and the coal-burning end of his outfit has received little attention and his operating engineer less.

The economic phase has never been looked into by the majority of employers, and many of the engineers cannot get this across. This end of business consequently has suffered badly. It would seem almost a 50-50 proposition, with possibly more faults resting with the engineers themselves rather than their employers; unquestionably there are faults on both sides. The fact remains that the operating engineers are very generally underpaid.

If coal could suddenly be increased to $20 per ton, the conditions of the operating engineers would change almost instantly, because heat and power would then be a different thing in the manufacturing cost sheet. As it is now, coal is such a relatively small item the employer does not take any interest in the power plant, when in fact without this department functioning properly the whole industry is hamstrung.

We will agree there is a disease here that might spread and cause more or less disturbance to our industrial structure. As a cure we would suggest that the employers join their underpaid engineers to fight their common battle together and cut out this fighting each other.

EGBERT DOUGLAS,
Cahill & Douglas,
Milwaukee, Wis. Consulting Engineers.

Selection of Alternating-Current Motors

The article in *Power*, April 6, by Egbert Douglas, entitled "Causes and Suggested Cure for Low Power Factor," interested me very much, as the installation that I have just completed violates many of the principles laid down by his article. The installation in question comprises approximately 9,000 hp. in motors, some 90 per cent of which are 720 r.p.m. synchronous speed or below. Incidentally, to avoid future argument the load at 4,300 kw. has a power factor that varies between 92 and 97.

Mr. Douglas ably presents the argument from the viewpoint of the power companies and the purely electrical efficiency, but leaves the impression that an installation as mentioned above shows poor judgment and a waste of money. Too narrow a viewpoint frequently leads us to a careful scrutiny of individual features to the exclusion of the problem as a whole. Many engineers are prone to purchase motors and starting equipment for high electrical efficiency and power factor at the lowest cost consistent with high-class equipment.

In reality the problem is much broader. The problem is actually the purchase of equipment for applying power to the parts of the machine which accomplish the useful work and suitable means for placing the control of the power at a convenient point in the hands of the operator. Good engineering would indicate careful consideration of the electrical and mechanical features of the installation as a whole. The latter is of more importance than the mere cost and characteristics of the electrical equipment only.

Power-transmission equipment of all kinds is expensive both in first cost and in maintenance, and adds friction loads which frequently form a large portion of the all-day load. Interruptions from the mechanical failures are more frequent than from electrical causes.

The guiding star in the design of the installation should be low unit cost of the finished article. This is most easily attained by uninterrupted operation at or near the maximum productive rate, implying maximum reliability and life of equipment. The closer we can apply the power to the working parts the less apparatus is introduced which may cause trouble and interruptions in service. A motor directly connected to the working parts of the machine with a minimum of transmission equipment presents the most ideal condition from the viewpoint of operating control and continuity of operation. This cannot always be attained in practice, but the more nearly it is followed the less interruptions may be expected. No one questions the advisability of direct connection for high-speed rotary apparatus such as fans, blowers, centrifugal pumps, or equipment of that type.

In the design of machines involving several processes, the use of individual motors frequently reduces the cost of the machine and increases production through better control of its component parts. This is especially true in the high-speed saws and cutters of the more complicated wood-working machinery.

A large portion of the work done in industrial processes is accomplished by machinery running at slower speeds than are general for motors. It frequently happens that the cost of the equipment for reducing the speed and applying the power to the machine is much more than the cost of the motor. For instance, assume a screw conveyor operating at 60 r.p.m. and requiring 30 hp. and individual drive. Comparative costs should include the cost of the motor, the cost of the transmission and reduction machinery, and the cost of the space occupied by the equipment. Considered on this basis the low-speed motor connected through a cut-gear speed reducer offers the lowest cost of installation, the lowest maintenance, the most reliable and convenient means of applying the power.

The superior reliability of the low-speed motor can be easily demonstrated. In several industries where much dust is encountered, the 720-r.p.m. synchronous-speed motor has almost attained the dignity of a standard. The parts are larger and less delicate. The large frames radiate heat better even when badly coated with dust. The liberal sizes of the shafts and bearings minimize troubles from belt pull and gear reactions.

Even the sin of overmotoring can be justified from the operator's viewpoint. Mr. Douglas states "There is probably no line of engineering work today where more guesswork is used than in selecting motors." From a wide experience in applying motors to industrial drives the writer can heartily agree that most manufacturers have a rather hazy idea of the actual power consumption of the machine they furnish. Then, too, conditions of application vary considerably from their standards. A good set of testing instruments should form a part of the equipment of every factory using any considerable amount of power, and frequent tests should be made of the power consumption of motors.

Abnormal conditions frequently arise which the operator will expect the motor to handle. As wear takes place, parts will get out of line and the friction load will increase. Machines will choke up and the operating delays and damage to material in process will frequently amount to more than the cost of the motor if the machinery stops.

The system power factor should receive attention, but not at the expense of the operating costs to the productive departments. So far as the average industrial plant is concerned, low power factor is not a serious item. Distribution lines are short and the allowance for extra copper is a small percentage of the construction cost. When power is purchased it becomes a different matter. The power company with long lines to build and extra transformer and generating capacity to furnish has a reasonable basis for an additional charge to the power cost for maintaining the extra equipment. In this case various corrective measures may be applied. A judicious use of synchronous motors or some of the newer types that have a leading power factor will usually take care of the problem. In extreme cases resort can be had to static or synchronous condensers.

T. H. ARNOLD,
Osborn, Ohio. Southwestern Portland Cement Co.

Is This Prevalent?

In reply to the query, "Is This Prevalent?" asked by C. F. Miller in *Power*, March 23, my reply is, Yes. universal. My observations of the status of the stationary engineer indicates that he is a much-imposed-upon and poorly paid individual and yet withal the most honest, capable and loyal member of the factory staff. We see him shoveling coal when a fireman is drunk, repairing a stoker or replacing a burnt-out light, always stepping into the breach of an emergency, doing hundreds of jobs, at the beck and call of everybody. His office is usually a cubby hole, badly lighted, dusty, oily and greasy, down near the boilers and engines, usually underground; in time he gets slack and loses faith and morale.

Recently, a small manufacturing concern asked to be advised if the expenditure of $16,000 a year for coal at $3.40 a ton to heat their premises was too much, three boilers being used at 110 lb. steam pressure. The owners were ex-farmers and graduated salesmen, knew nothing about engineering, although to hear them talk they had forgotten more than any engineering school ever taught. The reason their coal bill was $5,500 per annum too high was that, over the advice and recommendations of their engineer, they installed a heating plant and told him to operate it according to the specifications of a friend, which was to carry 110 lb. on the three 1,500-sq.ft. boilers, reducing it to 5 lb. for the heating.

A downward bend from the top of the boiler to the main steam pipe, prevented the moistened steam from dropping back to the boiler, it being siphoned to the main steam line and trapped to a hot-water heater which had a 6-in. open pipe to the atmosphere. There was a vacuum pump on the heating system, delivering through the hotwell directly to a 6-in. waste pipe. The engineer operated the plant until he got sick of it and asked for outside advice, to convince them the arrangement was wrong. I believe when it was all straightened out they gave him a raise of $5 a week.

I can quote dozens of instances where the owners have brought steam boilers to heat at 5 lb. when 2 to 4 oz. was all that was required. The owner does not know and he puts it all on the price of what he produces. The consumer, the grand old public, pays and pays, and smiles and smiles!

I may be wrong, but I believe there is a way out for the chief engineer. If you have a good idea patent it. There are registered patent attorneys who will prepare

your claims and drawings for $35. Therefore get out the old drawing boards and start the brain storms. Another thing, forget all that Marcus Aurelius stuff about little things. Engineers must study big things, big leakages, mass production. Forget the little things. Have an assistant to see to them. Another word: When you see a machine, say to yourself, "If I turn that thing upside down or stand it on its end, changed so and so, will it do more and better work or what machine will cut these out altogether." J. B. CARPER, M.E.

Louisville, Ky.

Hydrostatic Tests for Boilers

I have read a number of articles in *Power* on the question of which is the more reliable, an inspection or a hydrostatic test for determining the safety of a boiler. In the last six years I have examined and repaired a great many boilers and pressure vessels and must say that unless one is thoroughly familiar with the boiler, one must use both methods.

In 1920 the Portsmouth Navy Yard had a contract with the Shipping Board to recondition an ex-German liner, which had two double-ended and one single-ended Scotch boilers. The double-ended boilers were about 12 ft. in diameter and 20 ft. long. Their shells were made of three courses of plate, $1\frac{3}{8}$ in. thick, and the working pressure was 200 lb. per sq.in.

The contract specifically stated the work to be done, covering the repair of a number of minor leaks. Upon beginning work on the boilers, the first thing done was to make an examination of them, and they were found to be in an excellent condition. The next operation was to test them hydrostatically to locate definitely leaks and their extent. A pressure of 300 lb. per sq.in. was used for this test.

The first boiler tested required some time for a man to locate leaks and make some measurements. When test pressure had been on about 45 minutes, the top plate of the center course at the top center suddenly ripped asunder its full width of seven feet. This casualty required investigation for the cause and blame.

One of the points made was that the test pressure should not have been kept on the boiler for so long a time. The reply was that it was necessary for searching out leaks and measuring parts for distortion, and as the boiler showed that it had a factor of safety of less than 1.5, it was well it happened as it did rather than when steaming.

Instructions were then given to repair this boiler and a different procedure followed in testing the second boiler—which was to pump the pressure up to 300 lb. and then lower it to the working pressure.

All arrangements having been made, the test was begun. When test gage registered 300 lb., the shells of this boiler ripped asunder on the top center, from front head to back head, through the $1\frac{3}{8}$-in. plate, the two circumferential lap seams, and through a forged steel pad 4 in. thick used for mounting the main stop valve.

These boilers were accessible internally and externally for a thorough examination, the covering on the outside having been removed and the shells scaled. The condition, design and workmanship were remarkably good, and as the boilers were only ten years old, it appeared that a hydrostatic test would be necessary only to verify the tightness of the seams and the distortion of furnaces.

At this yard there are a number of boilers in power plants, locomotives, cranes, etc., which are inspected four times a year and tested once a year. Six of the crane boilers had been regularly tested and inspected up to the time they were four years old, when one of them developed a slight leak, coming through the apparently solid outside shell plate. These crane boilers are of the upright tubular type, inaccessible for a thorough examination, except through four small handholes.

This sort of an examination showed that the plates were not in a bad condition; and a water test, 50 per cent above working pressure, revealed nothing but a slight dampness above the mud ring. The mud ring was then removed, and its condition was found to be alarming. Both the outside shell and firebox plate on the water side were badly grooved just below the top of the mud ring, almost entirely around both plates, and nearly through in places.

The mud rings of eight more boilers were removed, and plating found in a similar condition.

THOMAS J. GAMSTER,
Navy Yard, Portsmouth, N. H. Master Boilermaker.

Buckling of Boiler Tubes

In the March 9 issue I notice a comment by W. F. Schaphorst on the article entitled "Buckling of Boiler Tubes," by W. Harris Day, in the Jan. 5 issue. I cannot agree with Mr. Schaphorst because his line of reasoning falls down with respect to fire-tube boilers. Here the tubes are in tension and not compression and so, if the top of the tube is the hottest and, therefore, weaker, it would stretch more than the bottom and the tube bend upward and not downward.

I believe Mr. Schaphorst has missed the main cause of the tubes deforming. In making steam in any vessel steam bubbles are formed and have a tendency to cling to the surface, thus insulating it. In a water-tube boiler the lower tubes do most of the work. There is also a considerable head for the steam to work against to reach the drum through the header. The header passage is also congested. All in all, the large quantities of steam formed in the two lower tubes and swept along by the circulation tends to rise to the top of the tube insulating the metal from the water. The metal at the top will, therefore, be hotter than that at the bottom, so that the tube will arch upward. The higher the rating the more steam available and the more chance for heating the top of the tube, as the header passage is more congested, and the chances for steam locking greater.

In a fire-tube boiler the circulation is not so brisk as in a water-tube for scouring the steam bubbles off the tubes. The steam bubbles will stick harder to the bottom than the top because their tendency to float upward will hold them against the bottom. Thus the bottom of the tube will in this case be better insulated, therefore hotter and longer, so that the tube will sag down.

Of course, in a water-tube boiler of the header type, there is considerable compression in the lower tubes, and once the tube starts to deflect, the compression will tend to increase this deflection.

This is the way the matter appears to me, and as the same line of reasoning holds for the water-tube as well as for the fire-tube boiler, it would appear to be more likely than the reason put forward by Mr. Schaphorst.

Toronto, Ont., Canada. L. D. WILTERS.

Are Welded Pressure Tanks Safe?

In *Power*, Feb. 23, E. Andrews spoke of welds generally, although he described the autogenous welding only. The so-called oxyacetylene welding is not a welding process at all and is in fact soldering. It is therefore not advisable to use it for high-pressure jobs. In addition to the points covered in the discussion there are others of importance, such as the internal stresses in the adjacent areas of the weld, caused by the heat of the weld-flame that cannot be calculated and have caused severe damage. One method practiced at most Austrian welding shops is not to stop with the welding process until the seam is finished in one direction. Welders in well-organized shops work in gangs of two men; one has the control of the burner and one hammers the seam, as he can reach it with the hammer without disturbing the welder in his work.

The proper way to be safe would be to anneal the welded product after it is welded and let it cool out in a packing of pulverized charcoal.

The severe test proposed in the article mentioned will not be agreed to by many engineers accustomed to handle high-pressure jobs, for instance, for the chemical industry. In my career I was called upon to weld some chemical apparatus that was to work under a pressure of 1,700 lb. per square inch. The work was carried out, tested with a pressure of 2,250 lb. and then annealed. Upon being put into service the apparatus worked satisfactorily.

Welding, in the purest sense of the word, is the process of water-gas-lap-welding as it is carried out by the Thyssen steel works in Mulhein-Ruhr.

The drums welded by Thyssen have proved satisfactory for steam boilers with pressures up to 600 lb. per square inch. These welds have done away with rivets. Engineers cannot use rivets in plates of 2-in. thickness and with an inside temperature of about 530 deg. F., at which temperature the material is surely to "age" and lose its strength.

Thyssen has adopted the following method in producing complete boilers or cylindrical drums in sizes from 2 to 6 ft. in diameter and up to 50 ft. in length. The plates come from the shears, where they are cut to the proper size, to the edging machine and finally to the bending machine. After being rolled, they are sent to the hydraulic welding press, where, after the beveled edges are fitted together, they are heated by water-gas burners to a forging heat, whereupon the edges are forged together by the press. The drum, which is not exactly cylindrical, is now subjected to a severe test with three times its ultimate working pressure, to see whether the weld is good and the joint tight. This testing pressure produces strains in the material and would, if there were no annealing process, cause the embrittlement of the material.

The welded and tested drum is then placed in a heated annealing furnace and after reaching the correct temperature is moved back to the bending machine, where the drum is turned until the temperature is reduced to normal.

The manufacture of boiler drums requires the constant attention of a real engineer and of the metallurgist at the iron and steel works. Although it robs the boiler maker of a good deal of his best-paid work, it does deliver drums free from dangerous internal stresses.

My advice would be to be careful not to overwork the material with high test pressures and not to use the hammer on vessels with a high inside pressure.

Vienna, Austria. ING. R. TH. HEINRICI.

Exhaust Versus Live Steam for Heating

From time to time the reader of technical magazines is asked to believe that it is possible to get something for nothing.

One of the frequent sources of this demand is from the operator of a plant using exhaust steam for heating or process work and in the form of a statement that his exhaust steam at 6 lb. gage pressure (or thereabout) is of more value for heating or process work than live steam at the same pressure.

Assuming that exhaust steam at this pressure will be about 90 per cent dry, we are asked to believe that the heating value of 90 lb. of steam and 10 lb. of hot water at 6 lb. gage is greater than that of 100 lb. of dry steam at the same pressure.

I, for one, find this hard to swallow. I have seen and heard this statement made several times, but have never seen sufficient data to prove it. Lacking proof, and having a working knowledge of the properties of steam, I should like very much to have someone produce some comprehensive data in support of the claim.

If the operator of one of these plants that is getting more heat out of 106,092 B.t.u. than can be obtained from 115,680 B.t.u. (or over 8 per cent for nothing) can tell me how it is done, he will not only be doing me a great favor but will, I think, be conferring a favor on the engineering fraternity at large.

Will someone, who is operating one of these plants, clear up a mystery of long standing by running a couple of tests (say of ten hours' duration each), one while using exhaust steam and one while using live steam, external conditions being the same in each case as nearly as possible.

The data taken and recorded hourly should cover at least the following: Boiler pressure, feed-water temperature, weight of coal burned, actual weight of water evaporated, pressure of steam at heating system header, pressure and temperature of steam at radiators or coils at three different points or more in the heating system, temperature of condensate at traps at the same three points, temperature of condensate at hotwell, temperature of outside air, temperature of rooms heated, number of persons working in rooms heated. Other data of value may be obtainable, but the foregoing, if properly taken, will go far toward clearing the "mystery."

The objection will probably be that this test will involve too much time and cost too much. In reply I will say that if the operator of one of these plants cannot see where he will be repaid for his time and expense, I will, if the plant is within 50 miles of my home, conduct the test for the privilege of writing it up and selling the write-up. If it is over 50 miles from my home and the management will guarantee traveling and reasonable living expense and grant the write-up privilege, I will do the job.

This is not a challenge to the economy of using exhaust steam at any back pressure. I fully realize the soundness of that claim. It is a challenge to the claim that exhaust steam is superior to and more economical than live steam—from a thermal standpoint.

Devon, Conn. L. A. PIERSON.

A new slant on things observed in and out of the power plant

What Happens and Why?

Easy Ways to Figure Strengths of Drum

OTHER things being equal, the weak point in a boiler drum or other drum subjected to internal pressure is the longitudinal joint. The formula

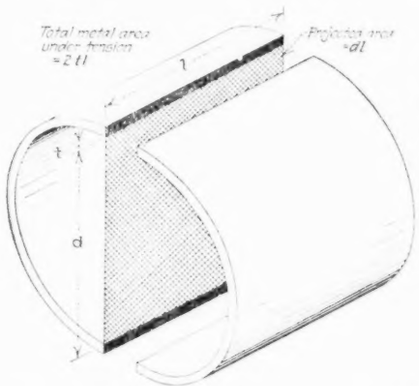


Fig. 1—Total steam force on projected area dl is carried by metal area 2tl

for figuring the safe working pressure of such a drum is

$$P = \frac{2\,s\,t\,e}{d}$$

In this P = safe steam pressure, lb. per sq.in.; s = safe working stress, lb. per sq.in.; t = thickness of shell,

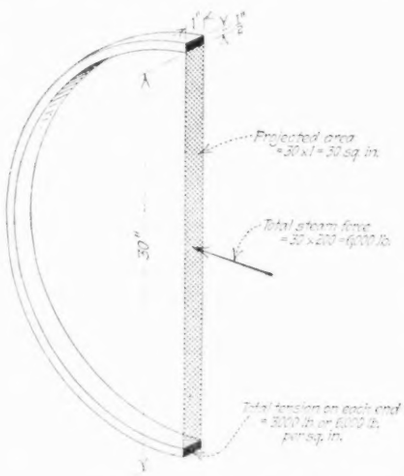


Fig. 2—Method using one-inch length and full diameter

in.; d = inside diameter of shell, in.; e = efficiency of longitudinal joint.

This formula is derived from the principle that the total steam pressure on the projected area is equal to the total tension in the metal resisting this pressure. In Fig. 1 the projected area is dl and the metal area $2tl$.

Since the length l cancels out, it makes no difference what length of drum is considered.

Simple as is this formula, there are still simpler ways of figuring the stress in such shells for a given steam pressure or, conversely, of figuring the steam pressure for a given allowable stress.

Imagine a one-inch strip cut from the half shell as shown in Fig. 2. This is permissible since, as has been shown, the length does not affect the result. The shell shown is ½ in. thick and has an internal diameter of 30 in. Assume 200 lb. steam pressure. This acts on a total projected area of 30 sq.in., giving a total force of 6,000 lb. Half of this, or 3,000 lb., is carried by the metal at one end. A tension of 3,000

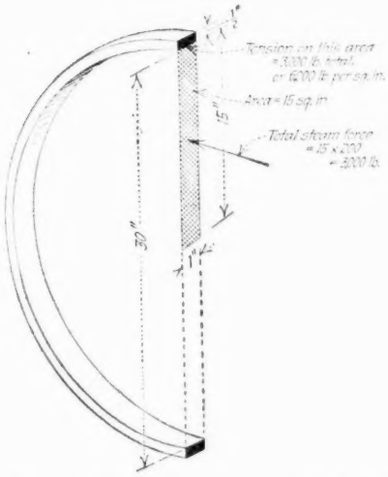


Fig. 3—Method using one-inch length and half diameter

lb. on ½ sq.in. of metal is equivalent to 6,000 lb. per sq.in.

Fig. 3 shows a further simplification. The projected area is here carried only halfway across the drum. The 3,000 lb. force on this area is carried by the metal in one end. A force of 3,000 lb. on ½ sq.in. gives 6,000 lb. per sq.in.

The variation shown in Fig. 4 may be still simpler for some. Here a length of shell is chosen such that the metal area at one end comes out exactly one square inch. (In the example illustrated the required length is two inches.) Taking the projected area halfway across the drum, the total steam force of 6,000 lb. is seen at once to equal the tensile stress in pounds per square inch.

The general case of this is illustrated by Fig. 5, where d = internal diameter and t = thickness, both in inches. Pick a section whose length is $\frac{1}{t}$. (For example, if $t = \frac{3}{4}$ in., take a length of $\frac{4}{3}$ in.) Then the metal area is 1 sq.in. Figure the steam force on projected area of which one dimension is half

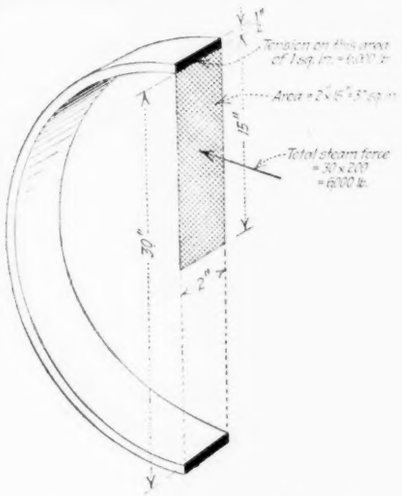


Fig. 4—Method using $\frac{1}{t}$ length and half diameter

the diameter and the other is $\frac{1}{t}$. This force will be equal the tensile stress in pounds per square inch.

For example, let the diameter be 40 in., the thickness ¾ in. and the steam pressure 200 lb. per sq.in. Take a projected area ¾ in. × 20 in. = 26.7

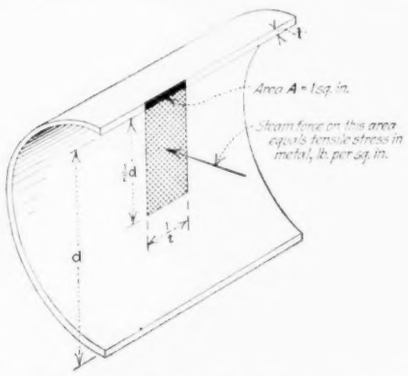


Fig. 5—Metal stress per square inch equals steam force on projected area

sq.in. The total force on this area is 26.7 × 200 = 5,340 lb. This is also the metal stress in pounds per square inch.

If this shell were seamless and the safe stress 8,000 lb. per sq.in., the corresponding steam pressure would be 8,000 ÷ 26.7 = 300 lb. per sq.in. If the shell were riveted with a joint efficiency of 0.7 (70 per cent) in the longitudinal seam, the safe pressure would be 300 × 0.7 = 210 lb.

Making Ice with Sub-cooled Water

At the April 8 meeting of the New York Chapter No. 2, National Association of Practical Regrigerating Engineers, Halbert P. Hill, of Ophuls & Hill, consulting engineers, New York, gave an interesting talk on new methods of freezing water. Apparently, his object was to stimulate thought along lines that take the ordinary operating engineer away from the beaten path. After having spent many thousands of dollars during about ten years on experiments to make ice by removing the heat from the water side of the ice instead of from the outside through the existing ice, he said that he still believes as firmly as ever that ice from sub-cooled raw water will ultimately become a commercial reality.

Depressing the Freezing Point

He stated that under certain favorable conditions the freezing point of water can be depressed as much as ten degrees below 32 deg. F. To do so the refrigerating medium must be not more than two degrees below the temperature of the water, otherwise ice crystals appear suddenly and the whole mass will soon become slush ice, opaque. The ice crystals do not group themselves so regularly as in the ordinary process of making ice, and as each crystal seems to be covered with a thick film of water, the ice has an opaque appearance. A method remains to be found for overcoming this disadvantage.

Some experiments have been made with double-pipe coolers, the freezing water flowing through the 2-in. pipe, the ammonia vapor passing through the 3-in. pipe, and the evaporating temperature being successively and cautiously reduced from about 34 deg. to 28 deg. If a piece of ice is dropped into water sub-cooled to 31 deg. F., $\frac{1}{144}$ of that water will flash to ice and the temperature will jump to 32 deg. The ice needles obtained are exceedingly small and of themselves they do not unite into a solid mass. If air agitation is used, snowballs result. These can be compressed into a solid cake. Operating thus with half ice and half water, the freezing time is 66 per cent shorter than if starting with plain water.

Process Not Yet Commercially Successful

As yet the method of making ice with sub-cooled water is not commercially successful, but it is very probable that in due time the process will be perfected. To get the water down to 20 deg. F., a very smooth glass surface is necessary, a surface of aluminum is too coarse, as is the surface of ordinary tubing or pipe. It invariably causes flashing into ice within the cooler, so the process must be interrupted.

G. Savavese asked the speaker why the Parsons system of making ice had proved to be a failure. In this system stationary ice cans of the usual 300-lb. size are used with three vertical double pipes projecting upward from the bottom of the can. In addition the cans are surrounded by cold brine. This system is in use at the Hudson Terminal Building, New York. Mr. Hill explained that with this method it was necessary to have the water exceptionally clean, agitation was difficult, and as a separate cylinder of ice is formed around each double pipe, it is nearly impossible to cut the ice as desired. The holes in the ice may be filled with water and frozen, but this takes extra work and is objectionable.

Charles H. Herter asked the speaker to explain to the audience his object in experimenting with sub-cooled water. The answer was, increased economy in the cost of making ice. He spoke of the moderate economy obtained with simple engine steam plants making distilled-water ice. Now we make ice from raw water, use uniflow steam engines, oil engines, or electric drive where current is available at favorable rates. The next step, he said, should be in the direction of improving the ammonia evaporating side of the system by operating at high suction pressures. If, by the use of sub-cooled water, the suction pressure can be kept at 43 lb. instead of 20 or 25 lb., the capacity of the compressor and its power per ton of ice will be affected very favorably and therefore the cost should be materially lower. It was true that ice from sub-cooled water was not transparent, but it was nevertheless fully as pure as the water it is made from.

Charles H. Herter supplemented Mr. Hill's remarks by stating that in his opinion sub-cooled water ice was commercially not feasible for the following additional reasons: It has been found extremely difficult to prevent formation where the lowest temperature in the system prevails, namely, within the water coolers, because the temperature difference between sub-cooled water and ammonia should not exceed 2 deg. F. This range is too narrow for successful continued operation. The water coolers having to have especially smooth surfaces inside, will be very costly, and expensive per ton because of the very small temperature difference used, which necessitates enormous cooling surface and with it radiation losses. The saving would not be so very great, for at present water and liquid ammonia are being forecooled at 43 lb. back pressure, and the freezing tank coils are operated at 25 to 30 lb. back pressure.

Status of Italian Electric-Power Industry

According to the United States *Commerce Reports*, April 12, the Italian electric-power industry made considerable progress during 1925. The installed capacity of central stations approximated 1,360,000 hp. prior to the war, 2,500,000 hp. at the end of 1923, 2,860,000 at the close of 1924, and 3,200,000 hp. at the end of 1925. The present available energy is furnished by more than 2,000 generating stations, 400 of which are of major importance.

The consumption of electric energy in 1925 amounted to 7,600,000,000 kw.-hr., more than three times that of 1914, when the total was 2,400,000,000 kw.-hr. Only 8.5 per cent of the energy consumed during 1925 was used for illumination, the remainder being utilized in the various industries and for traction. The per capita consumption of electric current increased from 70 kw.-hr. in 1914 to 185 in 1925.

Of the total installed capacity at the end of 1925, only 580,000 hp., used as stand-by, is steam-driven and only 300,000,000 kw.-hr. were generated during that year in these stations. If the entire 1925 output had been generated by steam, about 10,000,000 tons of coal, costing about $80,000,000, would have been consumed.

There are at present more than 100 water storage reservoirs in Italy, having a total capacity of about 860,000,000 cu.m. (30,300,000,000 cu.ft.) An additional 47, having a combined capacity of about 700,000,000 cu.m. (25,000,000,000 cu.ft.) are under construction, but will not be available for three or four years.

A comprehensive network of high-tension lines, which comprised 45,000 kilometers (28,125 miles) at the end of 1925, interconnects many of the various plants.

The equivalent of about $95,000,000 invested in the Italian electric-power industry at the end of 1914 had increased to about $254,800,000 by the close of 1925. About $72,000,000 was added during the last year alone.

A Timely Inspection

Prompted by a request for a special inspection, an inspector was detailed to examine a large rope-drive wheel that could not be made to operate smoothly. The master mechanic told the inspector that the wheel would not run true but wabbled, due, it was thought, to the shaft not being properly lined up. While the repairmen were preparing to line up the shaft, the inspector proceeded to examine the mammoth wheel.

The wheel weighed 43 tons and was 18 ft. in diameter, with a face width of 7½ ft., and was mounted on a shaft of 21⅝ in. diameter. The inspector carefully went over the wheel, giving it a minute examination, frequently having it turned into different positions to permit of a close examination of every part.

The first defect noticed was a slight crumbling of the metal on the lugs or supports under the binding links of the hub. This in itself had not progressed far enough to be considered serious except that it was evidence of the distortion of the wheel. Later, while down on his knees examining the shaft, the inspector found a crack in the shaft about two inches from the hub. It was barely visible at first, but after cleaning the metal in the vicinity, he was able to insert the point of the blade of a pocket knife into the crack far enough so that the knife was supported in a horizontal position. It was decided to discontinue the use of the shaft immediately.

The engine connected to the wheel was one of many in a large manufacturing plant employing thousands of men and containing acres of valuable machinery and buildings. The inspection was therefore timely as it undoubtedly averted a serious accident.—*The Locomotive.*

New and Improved Equipment

Worthington "Coniflo" Deep-Well Pump

In the June 19, 1923, issue of *Power*, a type of deep-well pump known as the "Axiflo," brought out by the Worthington Pump & Machinery Corp., New York City, was illustrated and described. This pump consisted essentially of a number of specially designed impellers placed at various depths in the well casing to impart an upward movement to the water column, guide vanes being provided immediately above the impellers to convert the velocity of flow into pressure and the circumferential tendency into a true axial flow. This line of pumps has recently been extended to include the "Coniflo" type pump, the driving head and impeller of which are illustrated herewith. The "Coniflo" pump is suited for wells up to 400 ft. in depth and has a greater head per stage than the "Axiflo" type previously described. It is recommended for wells over 150 ft. deep where the number of impellers required on a pump of the "Axiflo" type would be excessive. The impellers of the "Coniflo" pump are conoidal in shape, as shown in Fig. 3, which design combines the axial-flow principle with the radial-flow principle of the centrifugal type of deep-well impeller.

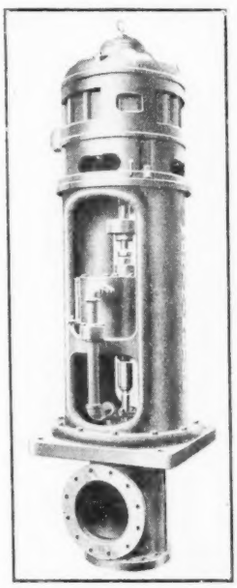


Fig. 1—Driving head of pump

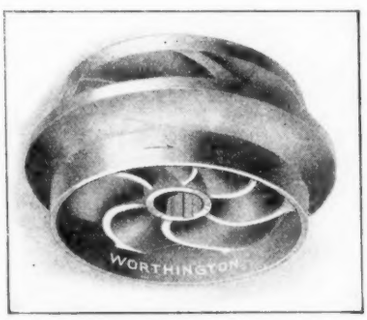


Fig. 2—Impeller of "Coniflo" pump

The driving head is the same as that used with the "Axiflo" pump, consisting essentially of a frame carrying the motor and the self-adjusting type thrust bearing shown embodied in the frame midway between the motor and the pump connection. This bearing runs submerged in oil, the oil bath being water-jacketed. Driving heads are furnished for direct-connected vertical motor or belt drive, and where water must be elevated to a considerable height above ground level, a centrifugal booster pump is added and connected to the pump shaft at the ground level.

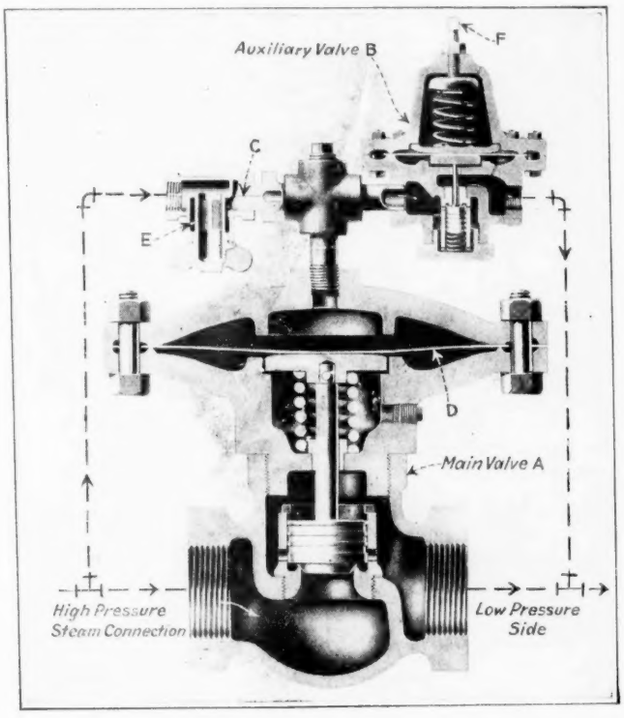
Spence Type ED Pressure Regulator

A type of pressure regulator operated by an auxiliary valve which may be located at any convenient point adjacent to or remote from the main valve, is a recent development of the Spence Engineering Co., Inc., 25 Church St., New York City.

Referring to the illustration, the operation of the main valve *A* is controlled by the auxiliary valve *B* connected as shown with the diaphragm chamber of the main valve *A*. The high pressure is connected to the inlet side of the strainer *E* which is fitted with an orifice or restricted connection *C* on the discharge side and through which the steam passes to the auxiliary valve and to the pressure chamber above the diaphragm *D* of the main valve. The outlet of the auxiliary valve is connected to the main delivery pressure line at the point of desired control.

It will be seen that as long as the auxiliary valve *B* remains open, there will be delivery pressure on the top of the main diaphragm *D* as the opening through the valve *B* is much greater than the small passage *C*—this will give the same pressure on either side of the main diaphragm *D*. When the pressure on the delivery or discharge side of the main valve reaches the desired point, the auxiliary valve *B* closes and this causes the pressure to build up on the top of the diaphragm *D* and close the valve *A*. Likewise, when the pressure lowers slightly the reverse takes place. This action of course is gradual in actual operation. The pressure on the delivery side of the main valve is changed as desired by adjusting the screw *F* on the auxiliary valve. One of the advantages claimed for this valve is that, by using the high pressure against a large metal diaphragm, positive operation and close regulation are secured.

The regulator is suitable for use on air, steam, water, oil or gases. The restriction body *C* is made of Monel metal and is protected against foreign materials in the steam by the strainer *E*. The valve is made in sizes from ½ to 8 in.



Pressure regulator with auxiliary valve control

News in the Field of Power

Power Companies' Bid for Muscle Shoals Wins Majority Support in Committee

Acceptance of Offer by Combined Fertilizer and Power Companies Appears Certain—Advantages in Defense and Money Return Assured U. S.

WHETHER or not the offer of the Southern power companies for Muscle Shoals is accepted at this session of Congress, the prevailing opinion on Capitol Hill seems to be that this offer eventually will be approved. Providing that all the power not used in fertilizer production is to pass into public-utility use, the program is strongly supported by labor, as it is expected to provide for the maximum amount of new employment. The monetary return to the government, $183,000,000 over the fifty years, is more than twice the return under any other offer.

The Joint Congressional Committee which has been considering the Muscle Shoals problem since March 15, in cooperation with an interdepartmental committee of experts, recommended on April 26 the acceptance of offers made by the Muscle Shoals Fertilizer Co. and the Muscle Shoals Power Distributing Co. These two companies were formed by thirteen Southern power concerns for the purpose of undertaking the functions indicated by their names.

Originally, there were nine bids submitted for the government's properties on the Tennessee River. Of this number, however, only three were considered, and finally the question narrowed to a selection of either the bid of the power companies or that of the American Cyanamide Co. Four of the six members of the committee supported the power companies' bid. Senator Heflin supported the offer of the American Cyanamide Co. and Representative James, of Michigan, opposed the acceptance of any one of the offers submitted.

Senator Deneen of Illinois, chairman of the joint committee, gave out the following summary of the bid from the associated power companies:

A. For Dam No. 2 alone....	$ 88,300,000
B. For Dams Nos. 2 and 3..	109,348,000
C. For Dam No. 2 alone, but with primary horsepower increased by headwater storage developed by private interests within ten years	$136,300,000
D. For Dams Nos. 2 and 3 with primary horsepower increased by headwater storage developed by private interests within ten years	$181,348,000

Senator Deneen issued a statement on behalf of the majority of the committee, a few points of which follow:

"The committee reaches its acceptance of the bid on the following basis:

"National defense is adequately served by this offer. The present plant or its equivalent in respect to capacity is to be maintained (until released by Congress) in its present state of readiness for the manufacture of explosives, the premises and personnel may be taken over by the United States whenever necessary in the interest of national defense, and a maximum amount of power is rendered available from the interconnected system for war industries.

"Agriculture is served by a definite program of fertilizer production up to and beyond the present capacity of the plant. Operation is for the production of nitrates primarily with rigid limitations on profit and strong guarantees on performance.

"In addition to insuring an economic program of nitrate and fertilizer production, the bid provides the largest monetary return to the United States of any of the bids considered. First, with the properties as they now stand without further expenditures by the United States; secondly, they provide larger financial returns for increased power at these properties due to upstream developments regardless of whether these latter are made by the United States or by other interests."

Senator Deneen issued the following personal statement reviewing his attitude in favor of the proposal:

"The majority of the committee favor acceptance of the proposal submitted by this company.

"First, because their proposal adequately met the consideration of national defense.

"Second, because their proposal appeared to us to be the most beneficial to agriculture. A definite program for 40,000 tons of fixed nitrogen is provided. Production of 20,000 tons of fixed nitrogen within six years is guaranteed and production of additional nitrogen as assured demand comes from the farmers; whereas in the proposal of the nitrate company (the American Cyanamide Co.) production of nitrogen above 20,000 tons was contingent on upper river developments at large expense.

"Third, our analysis of the financial aspects of the proposal with respect to the monetary returns to the government indicate that the ultimate total return to the United States would be approximately twice the amount which the government would receive from the nitrate company (the American Cyanamide Co.) offer.

"Fourth, the Muscle Shoals Fertilizer Co.'s contract is guaranteed by the Power Distributing Co. and in event of default for six months by the Fertilizer company in the production of fertilizer the government has the right to terminate the power lease. There is thus provided means for the government to take back the electric power if fertilizer is not provided. No other proposal presented such adequate guarantees and such complete protection to the United States.

"Fifth, the proposal which we have recommended does not require appreciable expenditures by the United States, whereas the nitrate company's proposal requires at the outset an expenditure by the United States of an amount estimated at $32,500,000 and makes production of nitrate above 20,000 tons contingent upon additional expenditures by the United States which might increase the total to $75,000,000.

"Sixth, and lastly, an equitable distribution of surplus power under the proposal of the Muscle Shoals Power Distributing Co. is assured the Southeastern States under strict supervision and regulation of federal and state authority."

Canada Cold to Proposal Nationalizing Water Power

That there is very little sympathy among members of the Canadian Parliament with proposals to nationalize water powers, was manifested a few days ago during a debate in the House, which arose over a motion by J. S. Woodsworth, member for Winnipeg, calling for nationalization of all water powers and coal mines.

Mr. Woodsworth objected especially to the water powers of the Dominion being owned and controlled by foreign interests.

The opposite side of the question was championed by C. H. Cahan, member for Winnipeg, who was supported by leaders of parties on both sides of the House. Mr. Cahan said he was prepared to vindicate the proposition that the hydro-electric enterprises of the province of Quebec served the public as cheaply and successfully as the Hydro Electric Commission of Ontario. He contended that Quebec should be allowed to proceed along the lines of its own ideals, which were those of private enterprise and initiative. Mr. Cahan recognized a distinct difference between the mentality of Quebec and that of Ontario, asserting that it would be to induce it to go in for prohibition.

There were other reasons why Mr. Cahan opposed Mr. Woodsworth's ideal. He looked into the future when new sources of electric energy would be discovered which would render present water-power properties almost valueless. He maintained that in the meantime private ownership was more efficient and served the people more cheaply than public ownership.

Senator Copeland's Regulation Coal Bill Wins General Approval

Measure Gives Bureau of Mines Jurisdiction—Authorizes Creation of Emergency Board by President—Formal Endorsement Soon

THE bill for the regulation of the coal industry recently proposed by Senator Copeland has been approved along general lines by the Senate Committee on Education and Labor, according to a report published in the New York *Herald-Tribune*, April 29. Providing for a bureau of coal industry, headed by a director, the original measure, as changed, places the jurisdiction in the Bureau of Mines of the Department of Commerce. An addition, in substance the revival of the 1922 law, gives the President the power to name a fuel distributor during a period of emergency.

Containing three main provisions the bill calls for:

The authorization of the Bureau of Mines to establish a coal division for fact-finding purposes, relating to the tabulating and making public essential data of the industry, including the cost of production, profits, wages, working conditions and the like.

The second part empowers the President to create an emergency coal board, in the case of serious disputes between miners and employers—this board to investigate the controversy and report whether, if the controversy remains unsettled, the condition of disagreement will deprive the public of an adequate coal supply.

The third provision relates to public operation and gives the President power in emergency to take over and operate any and all coal properties needful to provide the public with fuel. Fuel distributors, as under the act of 1922, are also provided. Senator Copeland was instructed to prepare and resubmit the bill with certain minor changes. It is expected then to be endorsed and reported.

Senator Copeland said that there was danger of another great strike a year from this spring, when the contracts of the miners and operators in the soft coal fields expire.

International Body Forms for Standardization

A strong movement for the formation of an international body to be known as the International Standards Association, to develop and perfect industrial standards is now under way in a series of discussions being held in the Engineering Societies Building, 29 West 39th St., New York. This effort arises out of several international undertakings of basic importance, the majority of which are in the mechanical industries.

Examples of these are the standardization, on a national scale, of ball bearings; the harmonizing of European and American screw-thread systems upon which interchange and replacement of bolts, nuts and other threaded parts depend; unifying specifications for zinc; and the standardization of gaging methods and limits and fits necessary to interchangeable manufacture and mass production generally.

Electrical questions of the kind have for a number of years been effectively dealt with by a technical body of world-wide scope, the International Electrotechnical Commission. Other matters, however, have been without a similar central body to deal with them.

Advancing industrial demands and the growing needs of interchange of industrial products, equally important to manufacturing and importing countries, have made the question more urgent in recent years, with the final result of bringing about the present international conference, which was called by the American Engineering Standards Committee.

A few months ago, C. le Maistre, secretary of the British Engineering Standards Association, in co-operation with W. H. Tromp and G. L. Gerard, secretaries of the Dutch and Belgium associations respectively, presented a definite proposal for the formation of an international body. This came before each of the national standardizing bodies throughout the world, and has been fully discussed by them. The present conference is an outcome of this discussion, with a view to developing details of the organization which is to be created.

Higher Operating Pressure for Bennings Power Station

Plans for the design and construction of an extension of the Bennings Power Station, Potomac Electric Power Co., Washington, D. C., are rapidly taking shape. The station, which has at present a capacity 120,500 kw., will have installed a 30,000 kw. turbo-generator, designed for stage-extraction feedwater heating, operating at a steam pressure of 350 lb. and 700 deg. F. total temperature.

The existing station is operated with a steam pressure of 180 lb. and the new unit will be the first step toward higher operating pressures. In addition, four boilers will be installed having a capacity of 1,400 hp. with interdeck superheaters, water-cooled furnace walls and air preheaters. The contract has been placed with Stone & Webster, Inc., Boston., Mass.

Research in Refrigeration Gets International Support

The investigations and experiments incident to determining units and standards of refrigeration, conducted during the last seven years by the United States Bureau of Standards, recently received additional international recognition. The International Institute of Refrigeration, headquarters at Paris, France, has contributed for the use of the Bureau the sum of 15,000 francs, transmitted through the National Research Council, as an evidence of appreciation of the great value of the research work done and to encourage the continuation of such research. The sentiment as expressed by such contribution is2 most gratifying and indicates the need for further research work in refrigeration.

Nearly forty countries are members of the International Institute, which is confined entirely to direct government representation with the exception of the United States, which is represented by the American Society of Ice and Refrigeration.

To Found Ericsson Medal For Swedish Engineers

Honoring again the name and achievement of John Ericsson, renowned scientist and engineer, a biannual gold medal has been established by the American Society of Swedish Engineers to be awarded to Americans of Swedish birth or descent, or to Swedish citizens in recognition of distinguished accomplishments in science and engineering.

Awards will be made on recommendation of a medal committee comprising four members of the Swedish Academy of Engineering Science and four members of the American Society of Swedish Engineers. At the unveiling of the John Ericsson monument at Washington, during May, the first award will be made.

General Electric Company Considers Change in Stock

The board of directors of the General Electric Co., Schenectady, N. Y., at a meeting on April 23, approved and recommended a plan to change the present 1,850,000 shares of authorized common stock of a par value of $100 each into 7,400,000 shares of common stock without par value. The stockholders of the company will vote on the proposition at the annual meeting in Schenectady, May 11, a two-thirds affirmative vote of the stockholders being necessary for authorization.

Ontario Commissioner Bitter Over "Illegal Water Diversion"

Commenting on the recent power project, planning development on the St. Lawrence at Long Sault Rapids and at the Falls, which was filed with the State Water Power Commission, Albany, N. Y., by the American Super-Power Corporation, C. Alfred Maguire, a member of the Ontario Hydro Electric Power Commission, declared that no request should be made for a revision of the treaty between Canada and the United States respecting the water allotment at Niagara Falls until the illegal diversion of water by Chicago is stopped.

It was his opinion that the answer of the Canadian Parliament to those interests of New York State who are promoting the latest move should be: "Chicago must be stopped from destroying the Great Lakes Navigation system before any suggestion of a revision of the non-existent treaty will be entertained."

S. W. Parr Gives Chandler Coal Research Lecture

The Chandler medal, awarded annually by Columbia University for achievement in science, was bestowed upon Prof. Samuel Wilson Parr, professor of chemistry in the University of Illinois, at a ceremony Friday night in Havemeyer Hall, New York. Many distinguished men of science attended.

Professor Parr delivered the annual lecture, taking for a topic, "the Constitution of Coal." Dealing with problems of carbonization, Professor Parr called America's greatest expert in the chemistry of coal, told of the production by new methods of a smokeless coke of special utility to households, which yields gas in abundance.

"Studies on the constitution of coal require an altogether different method of procedure from the usual analytical processes ordinarily employed," said Professor Parr, who was a member of the committee of the American Engineering Council which made a nation-wide survey of coal storage.

"As a matter of fact, neither the so-called proximate nor the ultimate methods give any remote information concerning the real constitution of coal. The newer forms of study make use of the microscope, by means of which the ultimate forms of vegetal matter are revealed.

"Also by means of some solvent such as phenol, the coal may be divided into two fundamental type constituents, the non-coking and the coking compounds.

"Other methods which give additional information involve a study of chemical activity and interaction between the component parts.

"As a result of studies along this line it is revealed that coals, especially of the mid-continental area, are much more sensitive in their chemical characteristics to alterations than the coking coals of the eastern part of the United States, but by utilizing the information thus attained, it is possible to follow methods of procedure which will conserve these coking constituents and result in a coke of excellent density.

"Studies of this type on the constitution of coal, therefore, reveal the conditions that must be followed. It may be said further that these conditions suggest what is known as the low-temperature type of procedure in preference to the higher temperatures of the standard coking process.

"It is further of interest to note that by observance of the conditions revealed by these studies it is possible to accomplish a low temperature carbonization in a cross-sectional area of from twelve to fourteen inches, instead of the narrower section of five or six inches ordinarily assumed to be necessary.

"The coke produced was smokeless and especially adapted to household appliances, while the byproducts are of especial interest because of the fact that under the conditions prescribed a very considerable yield of gas is secured—from four to four and one half feet per pound of coal.

"The other main by-product, the tar, is of interest because of its type, which has an established commercial value."

Professor Parr was born in Granville, Ill., January 21, 1857. He received the degree of B.S. from the University of Illinois in 1884, and M.S. from Cornell in 1885, later studying at the University of Berlin, and at the Polytechnikum, Zurich.

During 1885-86 he was an instructor in general science at Illinois, and in the following year he became professor. He has held his present chair since 1891. A prominent member of the American Chemical Society, he is also a fellow of the American Association for the Advancement of Science and an active participant of other scientific bodies.

The Chandler Medal was established in honor of the late Charles Frederick Chandler, pioneer in the chemistry of this country and one of the founders of the American Chemical Society, which, with Columbia and other organizations recently honored the memory of Professor Chandler at a public meeting, at which addresses were delivered by Elihu Root and President Nicholas Murray Butler.

Central Stations Output of Electricity and Fuel Consumption, 1919-25

BASED on the operation of about 4,000 public-utility power plants, the Department of the Interior, through the Geological Survey, has tabulated in summary form statistics of the production of electricity and the relative consumption of fuel for the year 1925, as compared with the previous six years. The more important of the figures are as follows:

ANNUAL PRODUCTION OF ELECTRICITY

Year	Total Kilowatt-Hours	Water Power: Kilowatt-Hours	Water Power: Per Cent of Total	Fuel Power: Kilowatt-Hours	Fuel Power: Per Cent of Total
1919	38,921,000,000	14,606,000,000	37.5	24,315,000,000	62.5
1920	43,555,000,000	16,150,000,000	37.1	27,405,000,000	62.9
1921	40,976,000,000	14,971,000,000	36.5	26,005,000,000	63.5
1922	47,659,000,000	17,206,000,000	36.1	30,453,000,000	63.9
1923	55,674,000,000	19,348,000,000	34.8	36,327,000,000	65.2
1924	59,014,000,000	19,969,000,000	33.8	39,044,000,000	66.2
1925	65,870,000,000	22,356,000,000	33.9	43,514,000,000	66.1

ANNUAL CONSUMPTION OF FUEL IN THE PRODUCTION OF ELECTRICITY

Year	Coal, Short Tons	Fuel Oil, Barrels	Gas, M Cubic Feet
1919	35,100,000	11,050,000	21,406,000
1920	37,124,000	13,123,000	24,702,000
1921	31,585,000	12,045,000	23,722,000
1922	34,179,000	13,197,000	27,172,000
1923	38,954,000	14,679,000	31,433,000
1924	37,556,000	16,630,000	48,443,000
1925	40,222,000	10,246,000	46,521,000

COAL PER KILOWATT-HOUR

Year	Pounds
1919	3.2
1920	3.0
1921	2.7
1922	2.5
1923	2.4
1924	2.2
1925	2.1

Obituary

Andrew Charles Loudon, vice-president of The Superheater Company, Ltd., Montreal, died at his residence in Burlington, Vermont, on April 11, after a few days illness from influenza and pneumonia. Mr. Loudon was born July 7, 1883, at Valleyfield, Quebec. He entered an apprenticeship with the Canadian Pacific Railway in 1901 and later graduated from McGill University. Entering the employ of the American Locomotive Co., he remained in the engineering department until 1907, when he went with the Grand Trunk Ry. Leaving railway work in 1912, having served with the Delaware & Hudson R.R. and the Atchison, Topeka and Santa Fe Ry., he became associated with the Simmons-Boardman Publishing Co., and finally with the Superheater Co., of New York, in 1917 in the engineering and service departments. Three years later he took charge of the Superheater Company, Ltd., becoming vice-president, January, 1921. An A.S.M.E., Mr. Loudon was also a member of the Engineering Institute of Canada, the Engineers Club of Montreal, besides many social and fraternal organizations.

Personal Mention

Henry J. Freyn, president of the Freyn Engineering Co., Chicago, Ill., is back at his desk after several months' absence due to a sever illness and overwork. A long outing in North Carolina, it is reported, went far in restoring Mr. Freyn's health.

Calvin W. Rice, secretary of the A.S.M.E., recently arrived in England, with Mrs. Rice, on the first stage of his tour of inspection of industrial museums abroad. As a trustee of the Museums of Peaceful Arts, Mr. Rice will study the exhibits of Europe, visiting the collections at the Hague, Munich, Berlin, Prague, Vienna and Paris before his return.

Vern E. Alden, for seven or eight years assistant to the general superintendent, Consolidated Gas, Electric Light & Power Co., of Baltimore, Md., and prior to that in electrical design work with the Westinghouse Electric & Mfg. Co., has joined the mechanical engineering staff of Stone & Webster. The new connection dates from May 1, 1926.

H. F. Darby, Jr., for more than 20 years connected with the Cutter Electrical & Manufacturing Co., Philadelphia, and for the last six years sales manager of that organization, has resigned to organize a sales service for electrical and power machinery manufacturers. Mr. Darby states that he is about to visit manufacturing plants throughout the country and expects to establish headquarters in Philadelphia about June 1.

R. J. Robinson, engineer with Heine Boiler Co., writes that he is to be transferred from the St. Louis office to the firm's address at Cincinnati, Ohio

Personal Mention

Walter de L. Carr has joined the Connecticut Light & Power Co., at Waterbury, Conn. Mr. Carr served until lately with the Northern Indiana Gas & Electric Co.

Hartley Rowe, until recently engineer with Lockwood, Greene & Co., Boston, Mass., is now associated with the United Fruit Co., with headquarters in the same city.

T. D. Graham, who formerly represented the Republic Iron & Steel Co. in its New York office, has assumed charge of the Cleveland territory of Reading Iron Co. His address is 850 Euclid Avenue, Cleveland.

Business Notes

Webster Talmadge, engineering specialist, with offices until recently at 150 Broadway, New York City, has removed to new headquarters at 50 Church St.

Barrett-Christie Company, 37 South Clinton St., Chicago, is now representing, as agent in that city, Kieley & Mueller, 34 to 38 West 13th St., New York City, manufacturers of steam, water and air specialties.

The Foote Bros. Gear & Machine Co., 215 North Curtis St., Chicago, Ill., has recently appointed T. R. Saunders, 180 Milk St., Boston, Mass., as its representative for Rhode Island and the eastern half of Massachusetts. This office is under the direction of J. R. Shays, of the New York City office.

The Lindley-Dunning Manufacturing Co., 5120 Wakefield St., Germantown, Philadelphia, Pa., recently incorporated, reports that it will manufacture pumps and equipment for electric refrigeration in any quantity. The new company is headed by Elmer D. Dunning, formerly vice-president and general manager of the Dunning Compressor Co., Holmesburg, Philadelphia.

C. Cryster and **R. J. Pask,** of Chicago, have united to carry on a consulting engineering business in which they will specialize on power-plant and industrial-steam problems and the service management of isolated plants and buildings. The new firm began operations on May 1 with office space in the Tribune Tower, 435 North Michigan Ave.

The Jos. Hays Corporation, Michigan City, Ind., manufacturer of the Hays draft gages, flue gas analyzers, CO_2 recorders, and other combustible instruments, announces a slight change in name to The Hays Corporation. Joseph W. Hays, who founded the business in 1907, has disposed of his entire holdings in the company in order that he may devote all of his time to his practice as a consulting engineer, with headquarters at the Orpheum Bldg., Tulsa, Okla. Philip T. Sprague, who has been closely associated with the company for a number of years as vice-president and general manager, has been elected president.

Coming Conventions

American Boiler Manufacturers Association. D. W. Glanzer, 840 Rockefeller Bldg., Cleveland, Ohio. Annual convention at Homestead, Hot Springs, Va., June 1-2.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Regional meetings: Madison, Wis., May 6-7, and at Niagara Falls, May 26-28. Annual convention at White Sulphur Springs, W. Va., June 21-25.

American Order of Steam Engineers. W. S. Wetzler, 758 N. 44th St., Philadelphia, Pa. Annual convention at Moose Hall, Philadelphia, June 7-11.

American Refractories Institute. D. A. Texter, 2202 Oliver Bldg., Pittsburgh, Pa. Annual meeting at Bellevue-Stratford Hotel, Philadelphia, Pa. May 12.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

The American Society of Heating and Ventilating Engineers. A. V. Hutchinson, 29 West 39th St., New York City. Annual convention at Lexington, Ky., May 26-28.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Regional meeting at Providence, R. I., May 3-6. Spring convention at San Francisco, Calif., June 28-30.

American Water Works Association. W. M. Niesley, Assistant to Sec., 170 Broadway, New York City. Annual convention at Hotel Statler, Buffalo, N. Y., June 7-12.

Association of Iron & Steel Electrical Engineers. John F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Exposition and convention at Hotel Sherman, Chicago, Ill., June 7-10.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, begins Sept. 14. Erroneously announced as Sept. 6-11. Annual conventions and exhibitions of state association are scheduled as follows: **Indiana State Association,** F. L. Clifford, 653 South Union St., Kokomo, Ind., Convention at Lafayette, Ind., May 10-15; **Kansas State Association.** H. S. Dukes, School for the Blind, Kansas City, Mo. Convention at Abilene, Kans., May 19-21; **Illinois State Association.** O. Jacobsen, 837, Lakeside, Place, Chicago. Convention at Decatur, Ill., June 2-4; **New England States Association,** Freeman L. Tyler, 32 Briggs St., Taunton, Mass. Convention at New Bedford, Mass., June 16-19; **Ohio State Association.** T. S. Garrett, 2622 E. Second St., Dayton, Ohio, Convention at Newark, Ohio, June 17-19; **Connecticut State Association,** George F. Klopfer, 30 East Pearl St., New Haven, Conn., Convention at Norwich, Conn., June 25-26; **Wisconsin State Association,** R. L. Scott, Eau Claire, Wis. Convention at Milwaukee, Aug. 3-6; **Minnesota State Association,** C. A. Nelson, 800 22nd Ave., N. E. Minneapolis, Minn. Convention at Rochester, Minn., Aug. 4-6; **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City. Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

National Board of Boiler and Pressure Vessel Inspectors calls attention to the fact that the date of the organization's annual meeting at Chicago has been changed from May 17-19 to May 24-26.

National District Heating Association. D. L. Gaskill, Greenville, Ohio. Convention at Niagara Hotel, Niagara Falls, June 1-4.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, Atlantic City, May 17-21.

Trade Catalogs

Pumps—De Laval Steam Turbine Co., Trenton, N. J., Catalog E-1079 describes the mine pumps manufactured by this company.

General Equipment—Ernest E. Lee Co., 115 South Dearborn St., Chicago, Ill. A descriptive illustrated booklet of the products of more than a dozen manufacturers making feed-water regulators, ring coal crushers, boiler-feed pumps, piping, valves, expansion joints, recording and indicating instruments, soot blowers, magnetic separators, and minor accessories, distributed by this company. Catalog 26.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	April 26 1926
Pool 1	New York	$2.50@$2.85
Smokeless	Boston	1.43
Clearfield	Boston	1.75@ 2.00
Somerset	Boston	1.85@ 2.10
Kanawha	Columbus	1.40@ 1.70
Hocking	Columbus	1.40@ 1.70
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2 35@ 2.50
Central, Ill.	Chicago	2 00@ 2.15
Ind. 4th Vein	Chicago	2 10@ 2.25
West Ky.	Louisville	1 00@ 1.50
S. E. Ky.	Louisville	1 35@ 1.50
Big Seam	Birmingham	1.75@ 2.25
Anthracite Gross Tons		
Buckwheat No. 1.	New York	1.75@ 3.50
Buckwheat No. 1.	Philadelphia	2.25@ 3.00
Birdseye	New York	1.00@ 2.00

FUEL OIL

New York—Apr. 29, light oil, tank-car lots; 28@34 deg. Baumé, 5¾c. per gal.; 36@40 deg., 6½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Apr. 21, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.15 per bbl.; 26@28 deg., $2.20 per bbl.; 28@30 deg., $2.25 per bbl.; 30@32 deg., $2.30 per bbl.; 32@36 deg., gas oil, 6c. per gal.; 38@40 deg., 6.5c. per gal.

Pittsburgh—April 27, f.o.b. local refinery; 30@34 deg., fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6⅝c. per gal.

Dallas—Apr. 12, f.o.b. local refinery 26@30 deg., $1.58 per bbl.

Philadelphia—Apr. 14, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.93@$1.99; 13@19 deg., $1.74@$1.80 per bbl.

Cincinnati—April 26, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Apr. 20, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@36 deg., $1.40@$1.45 per bbl.; 26@30 deg., $1.50@$1.60; 30@32 deg., $1.65@$1.70.

Boston—Apr. 26, tank-car lots, f.o.b. 12@14 deg. Baumé, 4½c. per gal.; 28@32 deg., 5.85c. per gal.

New Plant Construction

Ark., Little Rock—Morgan Utilities Inc., M. B. Morgan, Pres., El Dorado, plans the construction of a 50 ton ice plant on the Little Rock-Hot Springs highway. Estimated cost $80,000.

California—P. B. Cross, 550 Montgomery St., San Francisco, is having plans prepared for the construction of a power development including diversion dam, canal, tunnel, etc. on Deer Creek in Tehama County to develop 18,629 hp. Estimated cost approximately $1,500,000. W. Van Norden, Mills Bldg., San Francisco, is engineer.

Calif., Long Beach—Long Beach Terminal Warehouse Co., is having plans prepared for the construction of a warehouse and cold storage plant on Water St. Estimated cost $150,000. E. H. Cline, Petroleum Security Bldg., Los Angeles, is architect.

Calif., Los Angeles—Hauser Packing Co., 2300 East 9th St., received low bids for the construction of a cold storage plant from Thorleifson & Platt, San Fernando Bldg. $112,092.

Calif., Los Angeles—Sun Realty & Investment Co., 742 South Hill St., awarded contract for the construction of 12 story office and stores building at 7th and Flower Sts. to J. V. McNeil Co., 5860 South Park Ave. Estimated cost $4,000,000. Steam heating system, 9 elevators, etc. will be installed.

Calif., San Jose — J. A. Kidward, 17 North First St., is having preliminary plans prepared for the construction of a 14 story hotel, theatre, office and stores building at First and Santa Clara Sts. Estimated cost $2,500,000. H. Fischer, 17 North First St., is architect.

Calif., Santa Ana—Santa Ana County is having plans prepared for waterworks improvements including a deep well, pump and motor, booster pump and motor, 100,000 gal. elevated steel tank, etc., here. W. K. Hillyard, Santa Ana, is engineer.

Conn., Marlborough—Town plans the construction of an electric light plant, south of falls and Marlborough pond.

Conn., New London—Bureau of Yards and Docks, Navy Dept., Washington, D. C., will receive bids until May 12 for the construction of an automatic refrigeration and cold storage plant including a 2 ton motor-driven ammonia refrigerating machine, etc. at Naval Submarine Base here.

Ill., Chicago—F. Recklenberg, 29 South La Salle St., is receiving bids for the construction of a 13 story apartment at 442 Wellington Ave. Estimated cost $750,000. R. A. Northquist, 77 West Washington St., is architect. A. Johnson, 77 West Washington St., is engineer.

Ill., Kewanee—City plans improvements to waterworks including 2 units of pumping equipment, new well, etc. Estimated cost $50,000. J. G. Palmer, City Hall, is engineer.

Ill., Olney—City is having preliminary plans prepared for the construction of a waterworks system including pumping equipment, etc. Estimated cost $100,000. Edward Flad Co., 1312 Chemical Bldg., St. Louis, Mo., is engineer.

Ill., Peoria—City plans an election July 20 to vote $500,000 bonds for improvements to park system including exhibition rooms, steam plant, etc.

Ill., Warsaw—City will soon receive new bids for the construction of a 250 g.p.m. sand filtration plant including pumps, motors, 100,000 gal. tank on tower, etc. Estimated cost $30,000. Edward Flad & Co., 1312 Chemical Bldg., St. Louis, Mo., is engineer. Former bids rejected.

Ia., Sioux City—Sioux City Gas & Electric Co., will build a 1,000 kw. emergency turbine for Sioux Station, 11,000 v., 3 ph., power circuit for Packing House Dist., one four kv. and two 11 kv. substations, 55 mi. 66 kv. high tension transmission line from Storm Lake to Rutland by day labor. Work will be done under the supervision of U. G. I. Contracting Co., Broad and Arch Sts., Philadelphia, Pa.

Mass., West Quincy (mail Braintree)—Granite Ice Co. Inc., 550 Adams St., Quincy, will build an artificial ice plant here. Estimated cost $40,000. Private plans. Work will be done by separate contracts under the owner's supervision.

Mich., Melvindale (Dearborn P. O.)—Village is having plans prepared for the construction of a sewage pumping station including two 4,000 and one 2,000 g.p.m. vertical motor driven centrifugal pumps.

Miss., Biloxi—People's Ice Co., L. Elder, Gen. Mgr., will build an ice plant. Estimated cost $50,000. Work will be done by day labor.

Miss., Gulfport—City Commissioners, will receive bids until May 29 (extended date) for furnishing and installing one 1,000 and one 1,500 g.p.m. motor driven centrifugal pumps direct connected to a 115½ ft. head.

Mo., New Madrid—City is having preliminary plans prepared for the construction of a complete sanitary sewer system including pumping plant, etc. Estimated cost $65,000. Edward Flad Co., 1312 Chemical Bldg., St. Louis, Mo., is engineer.

Mo., St. Louis—Bd. of Public Service, A. Pritchard, Dir., will receive bids until May 25, for foundation and sub-structure for power plant at Howard's Bend waterworks. Estimated cost $325,000.

Neb., Nelson—City, J. J. Pfeiffer, Clk, will receive bids until May 7 for improvements to waterworks including two 250 g.p.m. vertical centrifugal pumps direct connected to three hp. 220 v. motors, one 1,000 and two 250 g.p.m. horizontal centrifugal pumps direct connected to three hp., 220 v. motors, pump house, dam, spillway, etc. Estimated cost $30,000. Henningson Engineering Co., National Bldg., Omaha, is engineer.

N. J., Cape May—Mayor and Commissioners will receive bids until May 11 for the construction of a pumping station, 2,500,000 gal. daily capacity. Cont. 1, furnishing and installing one 120 hp. and one 180 hp. Diesel engines direct connected to generators, one 36 kw. generator; Cont. 3, mechanical equipment including motor driven centrifugal pumps, vacuum pumps, switchboard, etc. Remington & Vosbury, 509 Cooper St., Camden, are engineers.

N. J., Jamesburg — Institutions and Agencies, W. J. Ellis, Comr., Trenton, will receive bids until May 10, for pump house, pump, 250,000 gal. water tower, artesian well, etc., for State Home for Boys here. Estimated cost $35,000. A. B. Mills, 635 Broad St., Trenton, is engineer.

N. J., Newark—Newark Arena & Amusement Corp., c/o J. W. Franklin Co., 80 Wall St., New York, N. Y., having plans prepared for the construction of a hotel and theatre building including ice skating rink, swimming pool, etc., at Market Plaza. Estimated cost $5,000,000. N. Harris, 20 Branford Place, is architect.

N. J., Plainfield—Plainfield Ice & Supply Co., 222 Madison Ave., awarded general contract for the construction of an ice plant to Wigton-Abbott Corp., 552 West 23rd St., New York, N. Y. Estimated cost $75,000.

N. Y., Kings Park—State Hospital Commission, Capitol, Albany, will receive bids about May for electric generators and air compressors for Kinks Park State Hospital. S. W. Jones, Capitol, Albany, is state architect.

N. Y., New York—M. A. Fitzgerald, c/o Buchman & Kahn, 49 West 45th St., Archts., is having plans prepared for the construction of a 23 story office building at Broadway and 37th St. Estimated cost $1,900,000.

N. Y., New York—A. E. Lefcourt, 1351 Broadway, plans the construction of three 23 story office and loft buildings at 22nd St. and 7th Ave., 25th St. and 7th Ave. and 23rd St. and 7th Ave. Estimated cost $7,000,000, $10,000,000 and $8,000,000 respectively. Architect not selected.

N. Y., New York—Lower Broadway Properties, 36 West 44th St., awarded contract for the construction of a 35 story office building at Broadway and New St., to C. L. Fraser, 50 East 42nd St. Estimated cost $2,500,000.

N. D., Willow City — Rugby Light & Power Co., c/o M. A. Erickson, Rugby, has acquired the municipal plant and plans the installation of a 90 kva. oil engine unit here, also line from Rugby to Barton a distance of about 27 mi.

O., Cleveland—City will receive bids until May 6 for the construction of substructure for pumping station with two 100 g.p.m. ejectors at Barberton Avenue Creek. Estimated cost $25,000. R. Hoffman, City Hall, is engineer.

Okla., Chandler — City voted $80,000 bonds for improvements to waterworks including new reservoir, wells, pumps, motors, elevated tank, etc. Benham Engineering Co., Gimbel Bldg., Kansas City, Mo., is engineer.

Okla., Chickasha—O. L. Bingham, awarded contract for the construction of an addition to ice plant to A. J. Puckett. Estimated cost $45,000.

Okla., Covington—City plans an election to vote $35,000 bonds for improvements to waterworks including deep well pumps and motors, mains, etc. C. A. Wood, Stillwater, is engineer.

Okla., Enid—City voted $215,000 bonds for improvements to waterworks including pumping equipment, mains, etc. F. C. McGruder, is engineer.

Okla., Wagoner—City is having preliminary plans prepared for the installation of a new 250 hp. Diesel engine and generator unit in electric light plant. Estimated cost $30,000. Engineer not selected.

Pa., Philadelphia—John M. Driver, Inc., 1644 North 55th St., will soon award contract for the construction of a factory including boiler room at 57th and Lancaster Sts. Stetler & Dysher, Jefferson Bldg., are architects.

Pa., Sharon — Sharon Steel Hoop Co., S. P. Ker, Pres., plans to electrify mills 8 and 10 and remodel unit 14, also the construction of a gas plant and boiler house. Estimated cost $500,000. G. S. Warren, c/o owner, is engineer.

S. D., Sioux Falls — City has retained Maury & Gordon, 53 West Jackson Blvd., Chicago, Ill., Engrs., to make plans for improvements and extensions to waterworks including new pumping unit, 400 hp. Diesel oil engine connected to a 270 kw. generator; and double power pump 3,200 g.p.m., 300,000 gal. elevated tank, etc. Estimated cost $159,000.

Tex., Abilene—Abilene Cotton Oil Co., will soon receive bids for the construction of a cotton oil mill, 160 ton daily capacity, including electric power plant, etc. Estimated cost $250,000. Private plans.

Tex., Crosbyton—O. H. Hammer, Chillicothe, plans the construction of a 15 ton ice plant. Estimated cost $28,000. Private plans. Work will probably be done by day labor.

Tex., Edinburg — City plans extensions and improvements to water and light plants. A. J. Ross, is mayor.

Wis., Edgerton—City, C. A. Hoen, Clk., plans improvements to waterworks including a new well, 600 ft. deep, and installation of one 500 g.p.m. motor driven pump. W. G. Kirchoffer, Dean Bldg., Madison, is engineer.

Wis., Sheboygan — Northfield Co., E. Schultz, Mgr., 18th St. and Martin Ave., is having plans prepared for the construction of a 4 story factory including light and power plant. Estimated cost $50,000. E. Juul, Security Bank Bldg., is architect.

Wis., Soldiers Grave—Interstate Power Co., H. C. Ortin, Mgr., Dubuque, Ia., plans the construction of a hydro-electric power plant, here. Estimated cost $75,000. Engineer not selected.

Ont., Toronto—Toronto Rail & Harbour Terminals Ltd., 34 King St., E., awarded contract for the construction of an 8 story terminal including main and cold storage warehouses, power house, ice manufacturing plant, etc. to Parklap Construction Corp., 84 Pine St., New York, N. Y. Estimated cost approximately $5,000,000.

Quebec—New Quebec Central Light & Power Co., Ltd., Montreal, had plans prepared for the construction of a dam on Beaumont River, here, to develop 2 electric units to furnish electricity to Maddington and Sounding Lake.

N. Z., Wellington—Public Works Supplies and Tenders Board, will receive bids until May 25 for metering and switchboard equipment, also switchboard gear and accessories.